



RAPTOR RESEARCH

A Quarterly Publication of The Raptor Research Foundation, Inc.

VOLUME 18, NUMBER 4, WINTER 1984

(ISSN 0099-9059)

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Published quarterly by The Raptor Research Foundation, Inc. Business Office: Gary E. Duke, Treasurer, Department of Veterinary Biology, 295K Animal Science/Veterinary Medicine Building, University of Minnesota, St. Paul, Minnesota 55108, U.S.A. Printed by Press Publishing Limited, Provo, Utah 84602. Second-class postage paid at Provo, Utah. Printed in U.S.A.

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A QUARTERLY PUBLICATION OF THE RAPTOR RESEARCH FOUNDATION, INC.

VOL. 18

WINTER 1984

No. 4

RAPTOR COMMUNITY STRUCTURE OF A PRIMARY RAIN FOREST IN FRENCH GUIANA AND EFFECT OF HUMAN HUNTING PRESSURE

JEAN-MARC THIOLLAY

ABSTRACT - The diurnal raptor community of a primary rain forest in French Guiana was studied, both around a small isolated village and far from any human settlement. Twenty species were found in large areas of unbroken forest and 6 additional species only near edges and clearings around the village. The comparison between hunted and non-hunted patches of otherwise similar virgin forest showed that even a moderate hunting pressure (i.e., for food by few people) significantly reduces both mean species richness of sample counts and density of most primary forest raptors. The largest species may eventually disappear.

Other than regional avifaunas and local annotated lists, including birds of prey, I found no studies on any entire raptor community of a particular primary Neotropical rain forest. Most papers are restricted to short observations on feeding (Haverschmidt 1962; Greenlaw 1967; Smith 1969; Lamm 1974; Lemke 1979; Boyce 1980; Fontaine 1980) or breeding behavior (Laughlin 1952; Smith 1970; Strauch 1975). Very few are longer, behavioral (Peeters 1963; Fowler and Cope 1964; Skutch 1965; Rettig 1968; Gochfeld et al. 1978), or ecological studies (Voous 1969; Smith and Temple 1982).

The number of falconiform species is much higher in tropical American forests than in similar forests of other continents (Thiollay 1984). However, their overall density does not seem to be higher (pers. obs. in Africa, Asia and Central America). Tropical forest raptors are exceedingly difficult to see in their natural habitat, so much so that only one nest of *Micrastur* (5 species), probably the most widespread genus of Neotropical rain forest raptors, has ever been found (Mader 1979).

The avifauna of French Guiana is poorly known (see Tostain 1980), though type specimens of many species (including raptors) coming from this country were described nearly 200 y ago. This paper presents the preliminary results of a larger study designed for a rain forest national park in French

Guiana, and the effect of human hunting pressure on the non-game bird community of primary forest. The objectives were to determine: (1) the composition of the diurnal raptor community of a truly virgin Neotropical rain forest, (2) the closest estimate of the structure (relative abundance of species) of such a community, (3) the forest species occurring only near the edge of large clearings or associated secondary forest and not around smaller natural opening in otherwise unbroken forest, and (4) the result of a moderate human hunting pressure (mostly on non-raptor species) on the raptor community richness and species' abundance.

STUDY AREA AND METHODS

The study site was in south central French Guiana (3° 35' N - 53° 10' W) near the small village of Saül (50 inhabitants, mainly goldminers). There are no other settlements or clearings within a 100 km radius. The country was hilly (200 to 500 m) and completely covered with high, dense, primary rain forest. The rich flora (ca. 500 tree species) was described by Granville (1978) and the forest structure by Oldemann (1974). The mean canopy height was 30-40 m with the highest trees up to 60 m. Numerous treefall gaps and small streams (but no large rivers) increase habitat diversity. Mean annual rainfall was 2400 mm, occurring mainly from December to February and April to July. Precipitation was 96 mm in November (17 d) and 206 mm (24 d) in December 1983.

The village was surrounded by about 150 ha of plantations, old re-growth, secondary forest and an airfield. A network of 120 km of small trails helped when searching the forest within about 5 km around the village. Local people hunted there for food. Nearly all

medium-size or large mammals and birds were hunted. The following raptors were killed during my 6 wk study: 1 Harpy Eagle (*Harpia harpyja*), 1 Ornate Hawk Eagle (*Spizaetus ornatus*), 1 White Hawk (*Leucopternis albicollis*), 2 Red-throated Caracara (*Daptrius americana*) and 1 Bat Falcon (*Falco rufigularis*). According to the villagers, about 50 raptors/yr are killed. Hunting has begun there since the first gold miners settled less than 50 y ago.

The second area was located in the Massif des Emerillons, 50 km south of Saül. It is uniformly covered by a strictly virgin rain forest, similar to that of Saül but completely devoid of any human settlement (the nearest is Saül), even of nomadic indians, and never hunted. The study site was around a bare rocky outcrop which provided the only opening in the forest. Only faint markings were made along line transects which radiated in every direction.

In both areas, only primary, structurally intact forest was considered, but tracks, small openings and edges, from which soaring birds were searched, were included. In Saül this had an influence on the species composition since wider ranging soaring raptors coming from neighboring secondary habitats were recorded above the primary forest canopy.

After a preliminary survey in December 1981 — January 1982, counts were made from 22 November 1983 to 2 January 1984. The Saül area, studied in 31 d, extended over about 100 km², against less than 10 km² in the Massif des Emerillons, which was surveyed during 11 d. This period covered the end of the dry season and the beginning of the rainy season and little time was lost because of afternoon rains.

In spite of numerous attempts in other tropical forests, I have found no single method which can give an accurate figure of a whole tropical forest raptor community. Therefore, the following two complementary methods were used;

1 - The number of birds seen or heard within < 100 m on each side of the line transect, per 2 h spent slowly walking with frequent stops inside the forest, was recorded. Very noisy flocks of caracaras were more often heard than seen, and their flock size could not always be accurately assessed. Therefore, only the number of flocks was computed, irrespective of the actual number of individuals. No significant differences were found among times of day, so all hours have been lumped (rainy periods excluded). This careful search is the only way to detect all the non-soaring species, although more specialized methods (tape records, traps) may help to detect a higher proportion of some species.

2 - From edges, natural gaps on ridges or rocky outcrops dominating the forest, the minimum number of different individual birds seen flying over the canopy, or even sitting on exposed branches, was recorded during 2-hr periods, spent on the same spot in non-rainy weather. To account for the hourly variation of the species' soaring activity, the day was divided into 4 periods. Only birds within < 1 km (the range of visibility of a small raptor to the naked eye) were recorded.

Pooling the data from the 2 methods does not give an accurate figure of the entire community because of very different degrees of conspicuousness, and hence detectability, among species, hours, weather, etc. In spite of this, a rough and tentative estimate of the numerical proportion of each species in the raptor community will be made. The percentages were calculated on the maximum frequency recorded in any of the 2 methods (i.e., mean number of individuals seen per 2-hr period, either under or above the canopy, during the most favourable time of day). Such a treatment obviously underestimates the relative importance of inconspicuous species which rarely, if ever, soar (forest falcons (*Micrastur* sp.), Black-faced Hawk (*Leucopternis metanops*), etc.

RESULTS AND DISCUSSION

The first striking result was the higher mean species richness per sample count and abundance of raptors in non-hunted vs hunted areas, even when the natural primary forest in hunted area suffered no other disturbance than the occasional presence of a few hunters and goldminers. From the hunted to the non-hunted forest, the mean number of species per 2-hr sample increased both under (+ 53.6%, Table 1) and above the canopy (+ 40.9%, Table 2). The frequency of encounters with caracara flocks was 69.4% higher in non-hunted vs hunted area (Table 1). Similarly, the abundance of other raptors increased from the hunted to the protected forest by 46.6% (Table 1) to 93.9% (Table 2). This change in mean number of individuals seen/

Table 1. Mean number of individuals (or whole flocks of *Daptrius*) and species seen/2-hr periods of careful search within a 200 m wide strip under the primary rain forest canopy in hunted (Saül) and not hunted (Emerillons) areas. Vultures and kites seen soaring above the canopy are not included.

	2-Hr COUNTS	FLOCKS ($\bar{x}$) OF <i>Daptrius americanus</i>	INDIVIDUAL ($\bar{x}$) OF OTHER THAN <i>Daptrius</i>	SPECIES ($\bar{x}$) INCLUDING <i>Daptrius</i>
Hunted	128	0.36	0.15	0.56
Not hunted	28	0.61	0.22	0.86

Table 2. Mean number of individuals and species of raptors seen/2 hr period sitting in the upper canopy (excluding *Daptrius*), or most often soaring. Observations are within 1 km of the still observer, during the 4 periods of the day in hunted (Saül) and not hunted (Emerillons) areas.

		0600 H - 0900 H		0901 H - 1200 H		1201 H - 1500 H		1501 H - 1800 H	
	COUNTS	INDIVIDUALS ($\bar{x}$)	SPECIES ($\bar{x}$)	INDIVIDUALS ($\bar{x}$)	SPECIES ($\bar{x}$)	INDIVIDUALS ($\bar{x}$)	SPECIES ($\bar{x}$)	INDIVIDUALS ($\bar{x}$)	SPECIES ($\bar{x}$)
Hunted	33	2.20	1.24	11.90	7.18	4.33	3.25	2.02	1.55
Not hunted	12	1.50	1.50	20.33	9.33	6.83	3.80	11.00	4.00

2-hr period is the closest estimate available of actual density fluctuations. All the differences were statistically significant (Mann Whitney U-test, $P < 0.01$) for both the pooled four hourly periods (as above) and when computing them separately (except for the 6-9 hr period of Table 2). Such a constant trend, whatever the method used or the set of species considered, strongly suggests that a "normal" human hunting pressure from a small isolated village on both raptors (which are killed for food or fun) and more traditional game animals may deeply impoverish the raptor fauna.

Table 3 gives a tentative figure of the whole raptor community in the 2 forest areas. Table 3 takes into account only the highest value of the mean number of individuals recorded for each species either under or above the canopy in any set of the same 2 h samples. Indeed, highly conspicuous soaring species recorded over a 1000 m radius are mixed with smaller, very inconspicuous species of the understory, detectable over a much shorter range. Therefore, percentages cannot be representative of the actual relative densities and they are given only as long as better estimates are not available. The main goal was to compare two areas with the same methods in similar habitats at the same season. In this respect Table 3 shows that all species, except the *Accipiter-Micrastur* group (rarely soaring and thus badly sampled), reach a higher abundance in non-hunted than in hunted areas. However, excluding 4 species linked to secondary habitats (see below) and 4 species not recorded in the virgin forest (probably because of too short a survey or too small an area studied). The 2 communities have a rather similar diversity ($H' = 2.37$

in non-hunted vs 2.28 in hunted zone) and equitability index ($J' = H'/H'_{\text{max}} = 0.59$).

Among the 26 species identified, 6 were associated with clearings and secondary growths around Saül and 4 occurred in the samples when soaring (Black Hawk Eagle (*Spizaetus tyrannus*), Tiny Hawk (*Accipiter superciliosus*) or hunting Plumbeous Kite (*Ictinia plumbea*), Bat Falcon) over the unbroken primary forest, but never far from its edge. The last 2 species of this group, the Crane Hawk (*Geranospiza caerulescens*) and the Gray Hawk (*Buteo nitidus*) have only been recorded at the edge of the primary forest and hence are not included in any count. The lack of species around Saül such as the Roadside Hawk (*Buteo magnirostris*) or the Laughing Falcon (*Herpetotheres cachinnans*), common in secondary habitats at the northern edge of the Guianan forest, reflects the small size of the local clearing and the absence of other gaps over a huge surrounding area. Hereafter, all species will be typical of the undisturbed primary forest, even if most of them also occurred elsewhere in secondary habitats.

Three species continuously soaring high above the forest have a relative density obviously overestimated. The Greater Yellow-headed Vulture (*Cathartes melambrotus*) is the only *Cathartes* identified within the vast expanses of unbroken virgin forest. The two other congeneric species are common in northern Guiana around clearings, savannas and marshes. The King Vulture (*Sarcoramphus papa*) is as widespread as the previous species but it is proportionally more abundant in non-hunted areas (ratio *Cathartes/Sarcoramphus* = 1.1 vs 1.9 in hunted forest). The last very conspicuous species is

Table 3. Relative abundance of raptors in hunted (Saül) and not hunted (Emerillons) primary forests. N max = highest frequency (mean number of individuals seen/2 h) obtained in any method and time period. % = proportion of the species in the community (percentage of the total number) computed from the above frequency. Names are from the A.O.U. checklist, 1983.

	HUNTED		NOT HUNTED	
	N MAX	%	N MAX	%
Greater Yellow-headed Vulture, <i>Cathartes melambrotus</i>	1.66	13.6	3.00	14.0
King Vulture, <i>Sarcorampus papa</i>	0.88	7.2	2.66	12.5
Gray-headed Kite, <i>Leptodon cayanensis</i>	0.11	0.9	?	a
Hook-billed Kite, <i>Chondrohierax uncinatus</i>	0.44	3.6	?	a
Swallow-tailed Kite, <i>Elanoides forficatus</i>	1.60	13.2	4.00	18.7
Double-toothed Kite, <i>Harpagus bidentatus</i>	1.66	13.7	2.00	9.4
Rufous-thighed Kite, <i>Harpagus diodon</i>	0.22	1.8	0.33	1.5
Plumbeous Kite, <i>Ictinia plumbea</i>	0.90	7.4		b
Tiny Hawk, <i>Accipiter superciliosus</i>	0.11	0.9		b
Bicolored Hawk, <i>Accipiter bicolor</i>	0.22	1.8	0.08	0.4
White Hawk, <i>Leucopternis albigollis</i>	0.99	8.1	1.33	6.2
Black-faced Hawk, <i>Leucopternis melanops</i>	0.04	0.4	?	a
Great Black Hawk, <i>Buteogallus urubitinga</i>	0.33	2.7	2.00	9.4
Crested Eagle, <i>Morphnus guianensis</i>	0.11	0.9	0.50	2.3
Harpy Eagle, <i>Harpia harpyja</i>		c	1.00	4.6
Black and White Eagle, <i>Spizastur melanoleucus</i>	0.88	7.2	1.33	6.2
Black Hawk Eagle, <i>Spizaetus tyrannus</i>	0.44	3.6		b
Ornate Hawk Eagle, <i>Spizaetus ornatus</i>	0.33	2.7	1.33	6.2
Red-throated Caracara, <i>Daptrius americanus</i> ^d	0.44	3.6	1.66	7.8
Barred Forest Falcon, <i>Micrastur ruficollis</i>	?	a	0.03	0.2
Lined Forest Falcon, <i>Micrastur gilvicolis</i>	0.22	1.8	0.07	0.4
Slaty-backed Forest Falcon, <i>Micrastur mirandollei</i>	0.01	0.1	?	a
Collared Forest Falcon, <i>Micrastur semitorquatus</i>	0.02	0.2	0.03	0.2
Bat Falcon, <i>Falco rufigularis</i>	0.55	4.5		b

a = may exist but not identified

b = not seen and probably lacking

c = formerly known, but now a rare vagrant

d = number of flocks heard within a 1 km radius from vantage points used for the census of soaring species

the Swallow-tailed Kite (*Elanoides forficatus*) gracefully flying over the forest in flocks of 3 to 8 and roosting in high, emergent dead trees.

Two medium size kites, the Gray-headed (*Leptodon cayanensis*) and the Hook-billed are very local and might be associated with forest openings. The Double-toothed Kite (*Harpagus bidentatus*) is the most likely of all small forest raptors to soar over the canopy or spend long periods in upper exposed branches and it appears much more abundant than other similar sized species. It has certainly a higher

density than the congeneric Rufous-thighed Kite (*Harpagus diodon*) (6-7 times higher in the counts) which has only a slightly less conspicuous behavior. These 2 Kites may co-exist since I have seen them in the same patch of forest at two different localities. On the other hand, the Bicolored Hawk (*Accipiter bicolor*) is probably commoner than suggested by the results (see Table 3) since it rarely soars and is restricted to low levels of the understory.

The White Hawk is mostly found on the edge of clearings or natural gaps and often soars, whereas

the congeneric Black-faced Hawk has only been seen in dense undergrowth at medium height. Their conspicuousness is very different and their actual relative frequencies might be closer to each other than suggested by Table 3. The Great Black Hawk (*Buteogallus urubitinga*) is a conspicuous raptor (pairs often perform noisy displays) but patchily distributed along some forest streams or rocky openings.

The Harpy Eagle is the only species not recorded from the hunted forest (although one was shot just outside the study area). Thus, it appears to be the species most sensitive to human hunting pressure, directly and through lack of prey. During this study, I have never seen it soaring, unlike *Morphnus*, but adults are easily seen in the morning from granite outcrops dominating the forest, when they perch on exposed branches of the upper canopy. The Crested Eagle (*Morphnus guianensis*) has probably a higher overall density or a wider distribution than the Harpy. One pair of each of these species was followed from a vantage point above the Emerillons virgin area. From the distribution of their perch sites and display flight circuits, their respective territories seemed to be contiguous but not overlapping. No interspecific aggressive behavior was observed.

The Black and White Hawk-eagle (*Spizastur melanoleucus*) is the commonest eagle (but also the one which most often soars). The Ornate Hawk Eagle is the only *Spizaetus* in pure primary forest where it may be more abundant than *Harpia* and *Morphnus* together, but slightly less than *Spizastur*.

The Red-throated Caracara (*Daptrius americanus*) is by far the most noisy and conspicuous raptor, but it never soars. Nevertheless, it actually reaches the highest density of all raptors both in hunted and virgin primary forest, if the number of individuals, and not only flocks, is taken into account. They are always in territorial flocks of 3-9 birds often loosely associated with Toucans (mainly *Ramphastos vitellinus*) and Oropendolas (mainly *Psarocolius viridis*). Around Saül, on 6000 ha intensively surveyed, there were 12 flocks (at least 71 individuals). Elsewhere, the Yellow-throated Caracara (*Daptrius ater*) has been recorded only along rivers, and the lack of any sizeable river in the study area may explain why this species has never been seen there.

The 4 species of *Micrastur* (forest falcons) are exceedingly secretive and inconspicuous (unless

their voices are known). They are probably more abundant than suggested by the results and may be, together, as abundant or more than *Accipiter* and *Harpagus* because, among small raptors, they are the most frequently seen in the understory. The commonest species is the Lined Forest Falcon (*M. gilvicolis*). The Barred Forest Falcon (*M. ruficollis*), if accepted as a separate species (according to the criteria given in Meyer de Schauensee and Phelps [1978] and Schwartz [1972]) was definitely identified only once. The Collared Forest Falcon (*M. semitorquatus*) is widespread and the Slaty-backed Falcon (*M. mirandollei*) seems to be the rarest species of the genus.

CONCLUSION

The virgin state over several million ha of the forest in French Guiana affords a fair opportunity to answer the main question of this study which was to ascertain the influence, on the raptor community, of a small human settlement, with associated clearings and hunting pressure, within a large tract of primary rain forest. Although it is difficult to assess the accurate structure of a rain forest community, because of very different degrees of conspicuousness between species, the results strongly suggest that (1) small clearings of shifting cultivation and secondary growths attracted 6 additional species, apparently very rare and local (large gaps) in natural conditions and thus increased the overall species diversity, and (2) hunting pressure, though mainly on a few game animals, lowers the density of most primary forest raptors, especially the large species, some of which may eventually disappear (Harpy Eagle).

Hunting may depress raptor density both through occasional direct killing of sensitive hawk species (the largest ones which are likely to have the lowest natural density and reproductive rate), through reduction of their food resources (game species as well as other components of the disrupted food chains), or disturbance of shy species. Hunting pressure is the most widespread form of human activity in tropical countries, which usually adds its effects to those of forest destruction (logging, cultivation). Raptors are among the first non-game species to disappear in the process of human population growth and exploitation of the rain-forest and are thus suitable indicators of habitat disturbance.

ACKNOWLEDGMENTS

This program was supported by a grant from the French Ministry of Environment and the Ministry of Defense Nationale (helicopter transportation). I am grateful to J.L. Dujardin, experienced ornithologist, for his invaluable help both in the field and in preparing the expedition.

LITERATURE CITED

- A.O.U. 1983. Checklist of North American birds. 6th edition. American Ornithologists' Union.
- BOYCE, D.A., JR. 1980. Hunting and pre-nesting behavior of the Orange-breasted Falcon. *Raptor Res.* 14:22-39.
- BROWN, L. AND D. AMADON. 1968. Eagles, hawks and falcons of the World. Country Life Books.
- FONTAINE, R. 1980. Observations on the foraging association of Double-toothed Kites and White-faced Capuchin monkeys. *Auk* 97:94-98.
- FOWLER, J.M. AND J.B. COPE. 1964. Notes on the Harpy Eagle in British Guiana. *Auk* 81:257-273.
- GOCHFELD, M., M. KLEINBAUM AND G. TUDOR. 1978. Observations on behavior and vocalizations of a pair of wild Harpy Eagles. *Auk* 95:192-194.
- GRANVILLE, J.J. (DE). 1978. Recherches sur la flore et la végétation guyanaïses. Ph.D. Dissertation, Université du Languedoc, Montpellier.
- GREENLAW, J.S. 1967. Foraging behavior of the Double-toothed Kite to association with White-faced monkeys. *Auk* 84:596-597.
- HAVERSCHMIDT, F. 1962. Notes on the feeding habits and food of some hawks of Surinam. *Condor* 64:154-158.
- LAMM, D.W. 1974. White Hawk preying on the Great Tinnamou. *Auk* 91:845-846.
- LAUGHLIN, R.M. 1952. A nesting of the Double-toothed Kite in Panama. *Condor* 54:137-139.
- LEMKE, T.O. 1979. Fruit eating behavior of Swallow-tailed Kites (*Elanoides forficatus*) in Colombia. *Condor* 81:207-208.
- MADER, W.J. 1979. First nest description for the genus *Micrastur* (forest falcons). *Condor* 81:320.
- MEYER DE SCHAUENSEE, R. AND W.H. PHELPS, JR. 1978. A guide to the birds of Venezuela. Princeton Univ. Press.
- OLDEMAN, R.A. 1974. L'architecture de la forêt guyanaïse. Mémoire Orstom, Paris.
- PEETERS, H.J. 1963. Einiges über den Waldfalke, *Micrastur semitorquatus*. *J. Orn.* 104:357-364.
- RETTIG, N.L. 1978. Breeding behavior of the Harpy Eagle (*Harpia harpyja*). *Auk* 95:629-643.
- SCHWARZ, P. 1972. *Micrastur gilvicolis*, a valid species sympatric with *M. ruficollis* in Amazonia. *Condor* 74:399-415.
- SKUTCH, A.F. 1965. Life history notes on two tropical american kites. *Condor* 67:235-246.
- SMITH, N.G. 1969. Provoked release of mobbing. A hunting technique of *Micrastur* falcons. *Ibis* 111:241-243.
- SMITH, N.G. 1970. Nesting of King Vulture and Black Hawk Eagle in Panama. *Condor* 72:247-248.
- SMITH, T.B. AND S.A. TEMPLE. 1982. Feeding habits and bill polymorphism in Hook-billed Kites. *Auk* 99:197-207.
- STRAUCH, J.G. 1975. Observations at a nest of the Black and White Hawk-eagle. *Condor* 77:512.
- THIOLLAY, J.M. 1984. Species diversity and comparative ecology of rain forest falconiforms between three continents. Proc. ICBP World Conference on Birds of Prey, Thessaloniki.
- TOSTAIN, O. 1980. Contribution à l'ornithologie de la Guyane française. *Oiseau et R.F.O.* 50:47-62.
- VOOUS, K.H. 1969. Predation potential in birds of prey from Surinam. *Ardea* 57:117-146.

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Received 11 March 1984; Accepted 1 November 1984

BIOLOGICAL AND ETHOLOGICAL NOTES ON *Falco peregrinus cassini* IN CENTRAL ARGENTINA

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ABSTRACT - We describe the hunting range of a pair of Peregrine Falcon (*Falco peregrinus cassini*) near Cordova Argentina. Main food was the Eared Dove (*Zenaida auriculata*) and of 9 food pursuits seen the success was 66%. The hunting strategies used are outlined. The cliff used by the peregrines was also used by several other species and of these only the raptorial species were attacked aggressively while such species as the Ringed Kingfisher (*Ceryle torquata*) was attacked as displacement activity.

The subspecies of Peregrine Falcon (*Falco peregrinus cassini*) (Plate 1) has been found nesting with greater frequency in southern Argentina than in northern Argentina. Thus, finding a pair nesting in the centre of the country (Province of Cordoba) was important for us, inasmuch as it is the most northern nest we are aware of, located in Los Reartes Valley (31°60' S-64°50')¹, and it provided at the same time an excellent opportunity to study the species. The synthesis of our observations that follows occurred on 12 regular visits that spanned the breeding period (our first visit was on 20 July 1977, our last on 15 January 1978).

MATERIALS

Photos were taken from a hide situated 12 m from the nest. (Plate 2). The falcons became perfectly accustomed to it immediately. Super 8 film and voice recordings were also made.

RESULTS

Daily Non-Breeding Cycle - While most hunting took place at distant hunting grounds, the rest their activities take place around the breeding cliff. Our observations indicate that the pair was resident from at least July until the end of January, and perhaps they were there year round. As the sun first struck the cliff (ca. - 0900 H in August), each bird left its separate overnight roost and flew to stumps or sticks about 400 m in front of the cliff where they preened or sunned themselves. These preening roosts were about 150 m apart.

As they flew towards roosts, the Southern Lapwing (*Vanellus chilensis*), common in the area, gave alarm calls (in spite of the fact that the peregrines never preyed on them). After 30 min of sunning

and preening, they set out to hunt. The basic food for this pair consisted of the Eared Dove (*Zenaida auriculata*), which was ubiquitous. The falcons hunted independently or as a cooperative pair.

After feeding they roosted at a shaded spot on the cliff for the remainder of the day, or would bathe, until departing shortly before sunset to hunt again. At twilight their activity ceases completely, each one going to separate night roosts.

Uneaten prey was frequently cached on a ledge to be eaten the following day. They were a particularly noisy pair in their relationship, and the occasions when they were not connected in some way, either by vocalizations or visually, were rare. When 1 of the 2 returned to the gully, the 1 perched on the cliff always gave a characteristic call. Of the 2, the male disappeared from the cliff for longer periods, both in midwinter and during breeding time, when it provided the female with prey. In every case, its absences were never more than 2 h.

Territory and Home Range - The home range could be divided into 3 areas of defense in which they showed different reactions. The greatest area "defended" was the hunting ground, which covered several square kilometers and included the other 2 areas. The second was the territory they defended near the nest, of some 300 m (radius) starting from the nest. The third area was the breeding cliff, formed by the nest and its surrounding shelves. In the province of Cordoba, the limiting factor for the number of established pairs seems to be the distribution of cliffs with a sufficiently difficult approach so as to enable them to nest with relative security and not be disturbed; the other possible limiting factor, food (doves), is more than plentiful in all localities. In their "hunting ground" they displaced other competitive species [the male pursued and severely attacked an Aplomado Falcon (*Falco femoralis*) until it was expelled from the territory] or other unpaired peregrines; but they didn't attack other species that were appar-

¹Ed. Note - *F.p. cassini* is now (1984) known to nest several hundred km northward in Salta province, the northernmost province in Argentina. The authors have since located several pairs of peregrines in the Cordova region.



Plate 1: *Falco peregrinus cassini* at nest ledge in Cordova Province, Argentina.



Plate 2: Female *Falco peregrinus cassini* with young at nest in Cordova Province, Argentina.

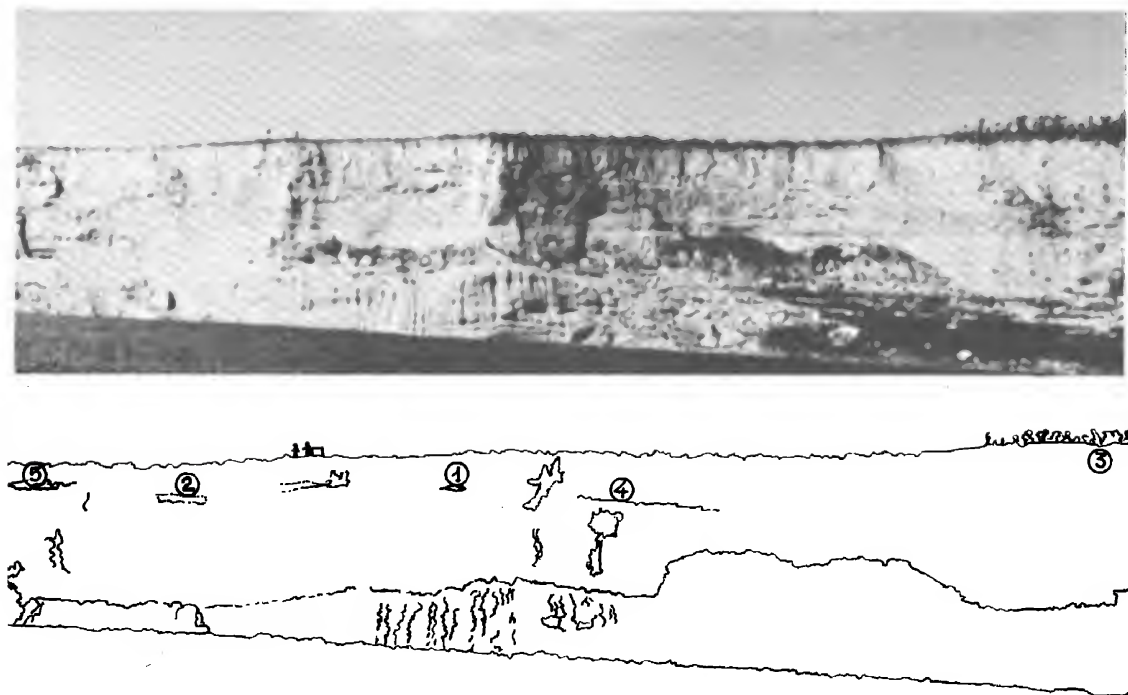


Figure 1. Cliff nest site characteristics for a pair of *Falco peregrinus cassini* nesting in Cordova, Argentina. Site 1 - Prey transfer area; Site 2 - Male's roost; Site 3 - Female's roost; Site 4 - Male plucking perch site; Site 5 - additional perch site also used for sunning.

ently non-competitive or did not serve as food (lapwings, gulls (*Larus* sp.), herons, Chimango Caracara (*Milvago chimango*), or American Kestrel (*Falco sparverius*). In attacks of other species in the "defended area", in all cases the female carried out the most aggressive defense and passed closest to the intruder. The male fulfilled the task of "support" by joining in calling, but his stoops were less decided and he nearly always watched the action flying above the female. The cliff had several characteristic points (Fig. 1) which were: the nest (1); a main eating and plucking ledge for the transference of prey (2); the male's sleeping roost (3); the female's sleeping roost (4); and a plucking and resting ledge of the male (5) also used for sunning.

Food and Hunting - The principal prey remains found below the plucking perch was the Eared Dove. Below the male's roost we found the remains of Monk Parakeet (*Myopsittia monachus*) and Screaming Cowbird (*Molothrus rufoaxillaris*) as well as those of the dove. Undoubtedly the male caught smaller birds (*Sicalis*, *Passer*, *Zonotrichia*, etc.), but we didn't find their remains.

Hunting - The principal hunting ground was in front of the nest on low-lying flat ground, partly bordered by the river that was a flying route of pigeons and doves. This hunting ground was where we observed most captures. At the height of the breeding season when large young were in the nest, we witnessed the pair hunting in a highly effective method (in 9 pursuits they achieved 6 captures = 66% success). The hunting method, used with very fast flying, medium sized prey, consisted of the following: in a succession of stoops at the pigeon (one after the other), the female falcon generally hit the pigeon as it tried to watch the male, who cut off its retreat while the pigeon looked for a refuge on the cliff or in the scrub (Fig. 2).

We were particularly impressed by the synchronization of movement they showed when hunting as a pair, from the first moment until they finally caught the prey. A sequence which we frequently observed was the following: they both flew over the cliff at a height of ca. 50 m, soaring against the wind (50-60 m apart); and while making notable head movements they searched the horizon for pi-

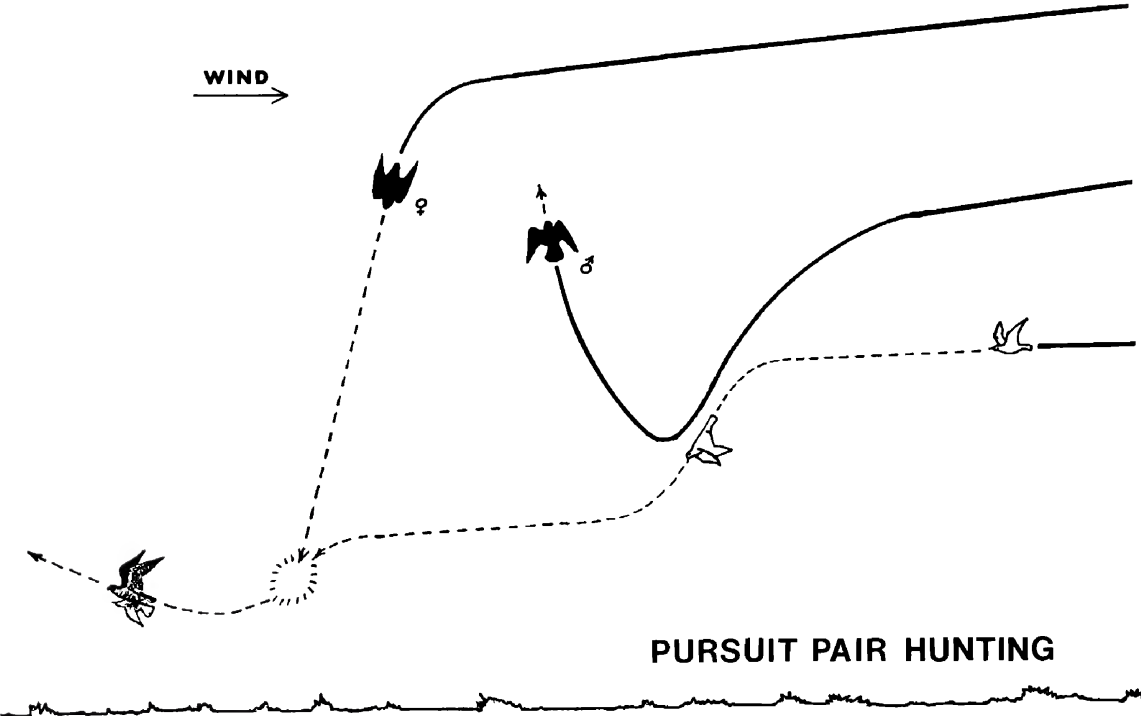
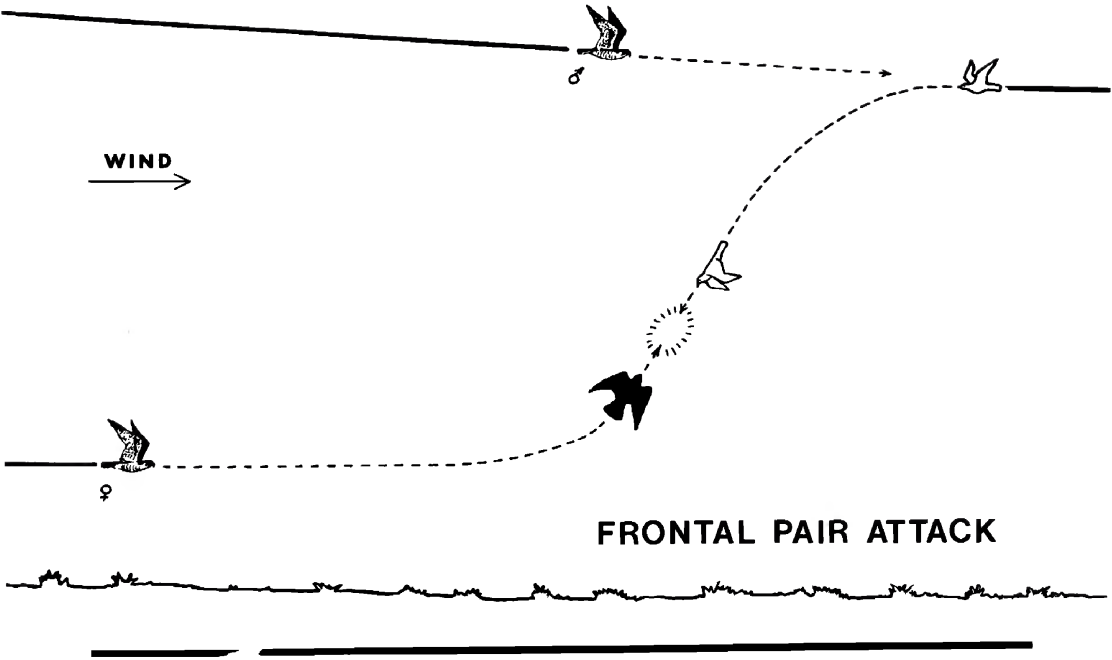


Figure 2. Hunting methods of *Falco peregrinus cassini*.

geons. The male always soared some 10 to 15 m above the female. When the male began to flap his wings, the female followed him at a distance of 30 m, beating her wings in the same rhythm. In an oblique flight, the female began to gain height, ready to stoop onto the prey which dodged the male's first dive. Most times, in the second dive, the female caught the prey. Out of 6 captures observed in 1 day, only 1 was made by the male, and the rest by the female. Similar strategies have been described and diagramed by Hustler (1983).

Young Eared Doves were more easily captured (most feathers found were from young). Some doves, nevertheless, were not able to be caught after a combined chase of more than 500 m, in which the male and female made a succession of stoops; until, to save themselves, the doves flung themselves like stones against the scrub of the cliff, while the peregrine gained height again, and, with repeated stoops to the ground tried to make the dove fly again.

Adaptation to the Surroundings and Relations with Other Species - The cliff face housed several species in addition to the peregrines. Each species seemed to coordinate their activities relative to the peregrines'. For example, a pair of the Ringed Kingfisher (*Ceryle torquata*) nesting near the falcons had to leave the cliff to save their lives when the female peregrine, molested by our presence, directed her attacks at whatever was below her.

? - when very near, turned in the air and took the prey.

We also observed another very effective combined attack: a dove approached flying towards the falcons, in an oblique direction. The male flew out to meet it and the female, flying behind him but lower (about 5 m above the ground) made her much lower than the dove's line of flight. The dove was apparently unable to see the female falcon, but could see the male.

As it neared the male, the dove turned sharply, descending and practically hitting the female, who had by now gained sufficient speed flying low, that she only had to attack from below, rising upwards to catch her prey (Fig. 2). On this occasion the female killed and partly plucked the dove while still on the wing. Of several prey captured in 1 day, only 1 was killed on the ground, the rest in flight by biting the neck.

During the time we observed the cooperative hunting described, the nestlings were about 20 d old and the female left the nest for long periods to join the hunting male. When the male brought food

to the female, he usually perched 30 m from the nest and called to the female. They were very vocal at the food exchange with a characteristic call (Fig. 3).

Considerations of Food Habits - Of several checks for food on the plucking perches, we only found remains of *Zenaida auriculata*. One, recently killed (still warm) and intact, weighed 130 g. Comparatively, the Spotted Pigeon (*Columba maculosa*), also frequent in the area, must be difficult to hunt; and it is our opinion (which we could not confirm in the field) that the male peregrine (*cassini*) could not transport in flight one of these pigeons that weighs, on average, 260 g.

All the doves were hunted and caught by direct pursuit because their size and agile flight enabled them to successfully evade a stoop. Larger prey that were difficult to carry in flight (ducks, etc.) were hunted by stooping perpendicularly from a considerable height and striking the prey. We found that the "waste factor" of this pair was high. Usually only the breast was gone from the dove. They caught about 3 doves a day and ate about 1/3 of each (40 g of muscles).

Based on the following scenario some calculations can be made. They daily consumed the equivalent of 12% or 15% of their body weight (according to temperature and activity level). The female weighed about 900 g, the male 650 g, and a dove weighed 125 g. During the rearing period each nestling consumed the equivalent of a little more than 1 dove/d (only about 5% of this pair's diet was not doves). Thus, we calculate that the pair and the 4 nestlings raised ate approximately 1750 doves annually. On a kg basis this value is in line with that derived independently by Ratcliffe (1980).

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Several times we observed these attacks. These were not attacks to kill and eat the kingfishers. On one occasion the kingfisher came in from down river, flying low over the water directly to its nest located about 50 m from the peregrine nest. The female peregrine started a sudden vertical dive-

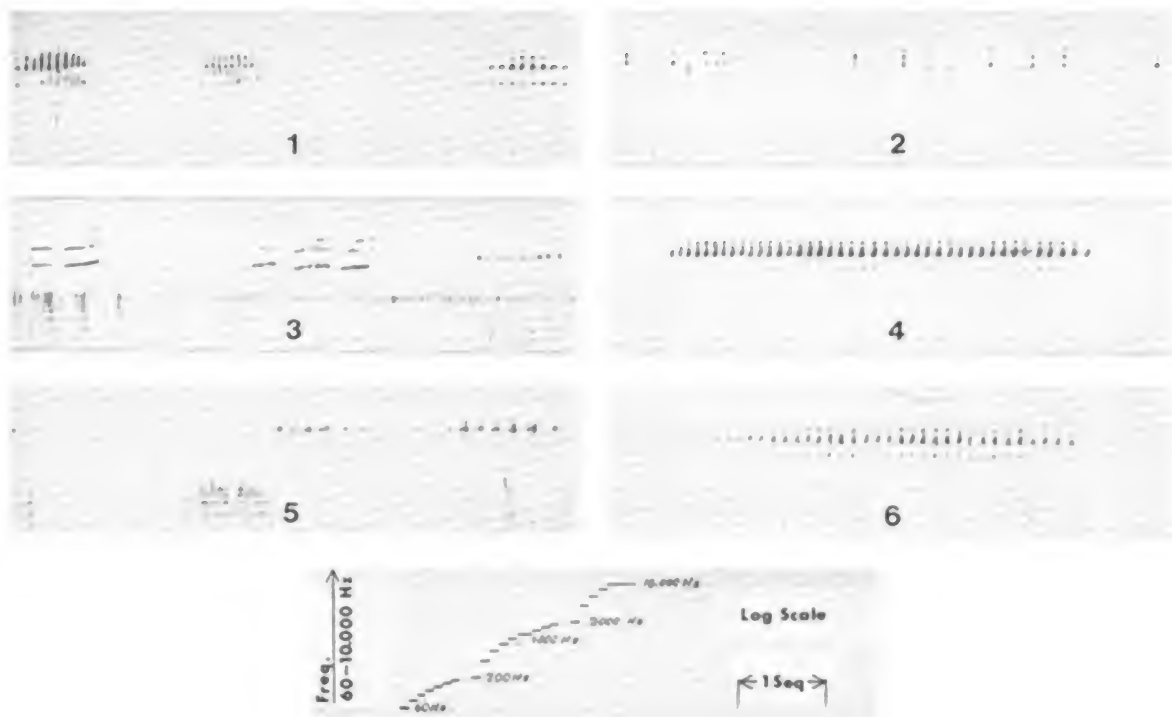


Figure 3. Miscellaneous sonogram patterns of *Falco peregrinus cassini* in central Argentina.

- Pattern 1: Alarm call of nesting female. The female was stooping at us near the nest. She made the calls (chitters) only when near us. The first vocal stanza is more dense than the other two because she was close by. The call ranges from 900-4100 Hz.
- Pattern 2: Contact call of the male. This call was given (*Eechip*, sometimes accompanied by ledge display) from the main eating ledge. Call frequency is from 600 - 5,000 Hz. Of note is that when the female approached him, the number of voices doubled in the same time lapse (ledge display). The latter is easily found in 1.5 sec of the sonogram from left to right. Then, when the female left, the call became more spatial after the 4th sec.
- Pattern 3: Anti-aggression call of perched male. This is also a submission call, since the female, while flying, will disturb or attack the male to make him fly. From the 5.25 sec, the female was close to the male, flying over him. His voice resembles total submission to the point of being like that of the young in front of their mother (compare 1st sec of Pattern 6).
- Pattern 4: Alarm call of the female with young. This sonogram reveals a more definite and persistent voice, more than when the nest contains only eggs (compare to Pattern #1). The call went from 1,000 - 5,000 Hz. In the same sonogram we found that young joined the female in the alarm call. This is noted in the difference in time between their voices, at 3.5 sec and from 4.75 sec, remaining even as the single voice at the end.
- Pattern 5: Alarm call of the male. Note the difference between the alarm calls of male and female. The male call was a mixture of a wail and a typical alarm call. The wail is a single frequency call lasting $\frac{1}{4}$ sec and the alarm call, a great variation of frequencies in $\frac{1}{4}$ sec. Both male and female alarm calls range in the same frequency (compare Pattern #3).
- Pattern 6: Call of nestlings. Their alarm call varied from 900 - 4,200 Hz. and resembled the alarm call of the adults in structure but not in the frequency range. The calls before 2.5 sec were the typical submission voice, that the male performs while the female is excited, aggressive or closeby (compare Pattern #3).

Notes: a) On the horizontal scale of the sonogram, each 4 divisions is one second (sec); b) Every character found in the sonogram below the 400 Hz range identifies parasitic and background noises from the wind.

attack the instant the kingfisher passed just below her, which caused the kingfisher to dive violently and loudly into the water. What impressed us most was the stoop of the peregrine, with a sudden movement of the wings, the body down in an almost vertical position, gyrated around the body axis. The wings accelerated the speed and the body returned to its normal position only at the end of the plunge. After passing just a few centimeters over the water, with a movement of the tail and due to the high speed the peregrine gained elevation to get into position for a second attack. The kingfisher surfaced and changed its flight direction, but the second attack forced it back into the water again. After repeating the maneuver several times, the falcon finished the game, allowing the kingfisher to leave the area.

Something very similar happened with a Speckled Teal (*Anas flavirostris*) that nested on the cliff about 30 m from the peregrines. Several times, flying to its nest, it had to enter the water because of the peregrines' attacks. However, unlike the kingfisher, once in the water it did not take wing to avoid the second attack, but swam away. Despite these attacks, the teal fledged a brood of young.

A group of swallows (the Southern Martin, *Progne modesta*, and Grey-Breasted Martin, *Progne chalybea*) also shared the cliff. They nested near the night roost of the male, and their presence was noticeable whenever the peregrines were resting or far away from the cliff. We used the swallows as indicators of the presence of the falcons because when the falcons were present, the swallows flew near the bush — protected cliff. Their alarm-call told us when the male came back to the cliff with prey.

Due to changes in the environment (swelling river after heavy rainfalls that floods lower lands), some species disappear temporarily. Among them, the Southern Lapwings (*Vanellus chilensis*) and Brown-Hooded Gulls (*Larus maculipennis*) made considerable noise whenever the peregrines were flying near despite the fact that they were never attacked.

The peregrine vehemently attacked Common Caracaras (*Polyborus plancus*) to a radius of 300 - 400 m from the nest. On the other hand, the Chimango Caracara (*Milvago chimango*) was not attacked, even when coming as near as 10 m to the nest.

Once we observed the male soaring about 800 m from the cliff. Suddenly he stooped at a Common

Caracara that was flying in front of the nest. On another occasion he pursued and drove away an Aplomado Falcon (*Falco femoralis*) that passed at a very high altitude over the cliff. We can confirm, however, that they do not attack either the American Kestrel (*Falco sparverius*) or the White-tailed Kite (*Elanus leucurus*). A pair of the former nested in a hole of the cliff about 500 m from the peregrines. The kite occupied two little woods of *Eucaliptus* and conifers about 400 m from the cliff.

ACKNOWLEDGMENT

We owe special gratitude to Walter Cerban, Cristian Henschke, and Christopher Clark for their collaboration in this note and to Clayton M. White for comments on the manuscript.

LITERATURE CITED

- HUSTLER, K. 1983. Breeding biology of the peregrine falcon in Zimbabwe. *Ostrich* 54:161-171.
 RATCLIFFE, D. 1980. The peregrine falcon. T & AD Poyser, Calton, England.

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Received 15 August 1982; Accepted 10 May 1984

BEHAVIOR OF THE AFRICAN PEREGRINE DURING INCUBATION

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ABSTRACT - Dawn-to-dusk watches were made during 5 d at a Peregrine Falcon (*Falco peregrinus*) nest with eggs in the Transvaal and all activity was recorded. The male incubated 35% of the day and the female 65%. Their incubation shifts averaged, respectively, 1 h 30 min and 2 h 25 min. Eggs were covered for 98% of the day. The female slept on the nest at night. The non-incubating bird was absent from the nest-cliff for periods averaging 2 h at a time and totalling about 3 h each day. It may have hunted during this time. Hunting by chasing and 'flushing' is described. Twenty-one prey items from 3 eyries were all birds, especially pigeons and doves (46%). The high share of the incubation done by the male, the abnormal hunting by the female during incubation, and the apparent rarity of Peregrines in the Transvaal are discussed.

The status of the African race of the Peregrine Falcon (*Falco peregrinus minor*) is poorly documented, though it appears to be scarce and very localized throughout its range (Cade 1969; MacWorth-Praed and Grant 1957, 1962; Snow 1978). It is described as being a rare breeding resident and possibly threatened in South Africa (Siegfried et al. 1976). During a 3-yr survey of falconiforms in the Transvaal only 10 breeding pairs were located in 286,300 km² (Tarboton and Allan 1984). Data herein may give insight into the factors contributing to its rarity in South Africa, and may provide useful comparative data for similar studies being done on the Lanner Falcon (*Falco biarmicus*) (Kemp, *in prep*).

Detailed observations were made during 5 d at an eyrie in the eastern Transvaal Escarpment Region (Site 1). This paper describes observed breeding and hunting behavior of this pair and includes observations made at 2 other eyries (Sites 2 and 3). Obviously the behavior of a single pair may not represent the species as a whole; in the absence of other published data on the biology of the African Peregrine, these observations are given.

STUDY AREA AND METHODS

The peregrine pair at Site 1 laid eggs in 1979 on an old nest probably built by the Black Stork (*Ciconia nigra*) on a ledge 40 m from the base of a 140 m east-facing cliff overlooking a long, sloping valley extensively planted under pines and eucalyptus. When first located in May 1979 a single male peregrine was seen at the nest-cliff. Observations were made between 5-11 September when the site was occupied by a pair incubating 3 eggs. On 2 November the pair was accompanied by 2 just-fledged young. Both male and female were adult and they could be distinguished by their size difference and the male's noticeably brighter-yellow eye ring, cere and feet.

The nest-cliff was observed continuously from dawn to dusk for 5 d (5-8 and 11 September) totaling 61 h with an additional 2 h 5 min on 10 September. Three observers watched in rotation from a vantage point on the slope directly below the nest. Two tripod-mounted telescopes were used, one trained on the nest and the

other following the movements of the non-incubating bird. All activity, including nest change-overs, agonistic behavior, activities while perched (e.g. preening), vocalizations, and flights were recorded. During periods of rapid action a cassette recorder was used to record activity.

Local sunrise and sunset at the site were, respectively, 0600 H and about 1745 H during the observation period, but it became too dark for observations after 1800 H and before 1530 H. The nest was shaded after 1330 H and the nest-cliff after 1550 H. During 3 d weather was cloudless and warm with little or no wind, and on 2 d it was cold, overcast and windy. No behavioral difference by the birds on clear and overcast days were noticed.

RESULTS

Eggs were incubated for 97.9% of the daytime ($n = 61$ h); on 4 d this averaged 99.3%, whereas on 1 d the eggs were covered for only 92.2% of the time. Both sexes incubated during daytime, but only the female spent the night on the nest ($n = 5$). Overall the female did the greater share of incubation, although on 1 d the male's exceeded the female's. The respective proportion of incubation ($\bar{x}/s.d./range$) during 5 d was, for the male: 34.7/17.5; 11.6-59.5, and for the female: 65.3/17.5; 40.5-83.4. If the female's overnight incubating is included, the respective male:female proportion of the incubation is 17.7:82.3.

Daytime incubating shifts by the female averaged 2 h 25 min (s.d. = 1 h 6 min, range = 29 min - 4 h 3 min, $n = 11$) and those of the male averaged 1 h 30 min. (s.d. = 1 h 17 min, range = 8 min - 4 h 14 min, $n = 14$) (the difference is not significant). The male had both the longest and shortest daytime incubating shifts (respectively, 4 h 14 min and 8 min), although if the female's overnight shifts are included, these would exceed the longest shifts by the male. Her longest continuous incubation shift in this case was 15 h 52 min.

Most observed nest change-overs ($n = 27$) were similar in that the relieving bird flew unannounced to the nest and alighted beside the incubating bird. One or both birds then uttered a series of 'tjak-ak'

Table 1. Total time during 5 d, given in min and as a percentage, in which the non-incubating bird was present at, and absent from, the nest-cliff.

WHEREABOUTS OF NON-INCUBATING BIRD	TIME (MIN)		%	
	MALE	FEMALE	MALE	FEMALE
Present at nest-cliff	562	735	42.0	30.7
Absent from nest-cliff	777	1637	58.0	68.3
Unknown	0	26		1.0
Totals	1339	2398	100.0	100.0

notes before the incubating bird flew off and the relieving bird incubated. Occasionally other vocalizations (e.g. whining 'weee-e-k') were used at change-overs. The male often (10/15 times) appeared to be reluctant to give up incubating when relieved by the female. On such occasions one or both birds called much longer than usual, uttering 25-30 'tjak-ak' notes. Invariably the female supplanted the male in these instances, whereas the male frequently ($n = 10$) came to the nest to relieve the incubating female but was unable to dislodge her. Occasionally ($n = 3$) the female had already left the nest when the male arrived to incubate and he took over silently.

There was no regular pattern of shifts by sex during the 5 d, apart from the first and last shift each day by the female. The male relieved her before sunrise (averaging 28 min before sunrise) on 4 of the 5 d. The female's last shift continued overnight and commenced at various times between 47 min - 3 h 59 min before sunset ($\bar{x} = 1$ h 54 min).

Activity of the Non-incubating Bird — Often the non-incubating bird left the vicinity of the nest-cliff, presumably to hunt since both birds returned after absences with bulging crops. When not incubating, the male was absent a significantly greater proportion of the time than the female ($P < 0.0001$, see Table 1). On average, the non-incubating bird was absent from the nest-cliff for about two-thirds of each day ($\bar{x}/s.d. = 8$ h 3 min/1 h 35 min; range = 5 h 17 min - 9 h 7 min, $n = 5$). The incubating bird was alone at the nest-cliff for 71% of the day (female) or 62% of the day (male).

The Crowned Eagle (*Spizaetus coronatus*), Jackal Buzzard (*Buteo rufofuscus*), Gymnogene (*Polyboroides radiatus*) and the White-necked Raven

(*Corvus albicollis*) were invariably chased and harassed by the non-incubating bird if they passed the nest-cliff when he or she was present. The incubating bird was never seen to leave the nest and assist its mate during these pursuits, nor did it attempt to chase off passing birds of prey when the mate was absent. On 1 occasion the nest-cliff and eggs were left entirely unattended for 55 min when the female left the nest to pursue, catch and eat a passing pigeon (see *Hunting Behavior*). Black Storks, which came and went continuously from an active nest about 500 m away on the cliff were not molested.

Typically both birds, at the end of an incubating shift, flew to a favored perch, defecated, and commenced preening, and later started other maintenance activities such as stretching, scratching or (occasionally) casting a pellet. On average, male and female spent, respectively 86 and 90 min/day (s.d. = 29 and 39 min respectively) actively preening on a perch (about 12% of each day). After a period of preening they usually became alert, looking about, making perch-changes or 'flush-hunting' (see *Hunting Behavior*) before taking flight, soaring high, and going out of view behind the nest-cliff.

Hunting Behavior — Most hunting and eating of prey apparently occurred away from the nest-cliff since only 2 successful prey strikes were observed in 5 d. In one of these the female left the nest to catch a passing pigeon which it ate away from the nest-cliff. In the other instance the male caught a small bird which it took back to the nest-cliff to eat. There was little prey pluckings below favored perches, and none at the nest, suggesting that during incubation prey was not frequently brought back to the nest-cliff to eat. During 5 d the male never brought food to offer the female and she appeared to provision

herself entirely. In the instance where the male returned to the nest-cliff to eat prey, the female left the nest and attempted to take the remains from him after he had eaten for 10 min. They grappled for the prey on the male's perch before it fell and was lost in the forest below.

In addition to 2 successful strikes, 5 unsuccessful chases (2 by female, 3 by male) and 1 probably successful strike (female) were initiated from the nest-cliff. Three of these 8 attempts (all by the female) involved chasing birds, twice pigeons, which were flying past at least 2-3 km distant. In one case she soared briefly to gain height before at-

tacking passing birds, flying with rapid wingbeats to a point ahead of the birds so as to intercept them. In one unsuccessful chase the 2 pursued pigeons changed direction as she approached, then dived downwards. She stooped unsuccessfully at them 3 times before they reached shelter in trees. In a second apparently successful chase the female's flight from take-off to strike lasted 120 ± 5 sec. It followed the same pattern in which the prey attempted to evade the peregrine by diving and the female spiralled down after it.

At site 2 a male stooped at and caught a swift (probably *Apus melba*) which was one of a large flock

Table 2. Peregrine prey recorded at 3 Transvaal eyries. Sites 1 and 2 are in the Escarpment Region, Sites 3 is in the Lowveld.

SOURCE OF DATA	PREY SPECIES	No.
1. Prey remains found below perches on nest-cliffs;		
Site 1	Domestic Pigeon, <i>Columba livia</i>	4
	Red-eyed Dove, <i>Streptopelia semitorquata</i>	1
	Laughing Dove, <i>Streptopelia senegalensis</i>	1
	Cuckoo, <i>Chrysococcyx</i> sp.	1
Site 3	Red-eyed Dove <i>Streptopelia semitorquata</i>	1
	Green Pigeon, <i>Treron australis</i>	1
	Burchell's Coucal, <i>Centropus superciliosus</i>	1
	Swift, <i>Apus</i> sp.	1
	Red-faced Mousebird, <i>Colius indicus</i>	1
	Lilabreasted Roller, <i>Coracias caudata</i>	1
	African Hoopoe, <i>Upupa epops</i>	1
	Rock Martin, <i>Hirundo fuligula</i>	1
	Blackheaded Oriole, <i>Oriolus larvatus</i>	1
	Starling, <i>Lamprotornis</i> sp.	1
	Small passerine	1
2. Prey observed being caught		
Site 1	Domestic pigeon, <i>Columba livia</i>	1
	Small bird	1
Site 2	Swift, probably <i>Apus melba</i>	1
3. Unsuccessful prey strikes		
Site 1	Rock Pigeon, <i>Columba guinea</i>	1
	Pigeon, <i>Columba</i> sp.	2
	Redwinged Starling, <i>Onychognathus morio</i>	1
	Small bird	2
Site 2	Rock Pigeon, <i>Columba guinea</i>	1

spiralling around in the valley below the nest-cliff. The stoop lasted about 10 sec. The bird covered about 1 km and dropped about 300 m during the strike. It took the swift in its feet as it passed through the flock.

In a second hunting method peregrines attempted to flush prey ('flush-hunting') from the nest-cliff and then pursue it. Both male and female frequently did this, though never successfully. In 'flush-hunting' the peregrine changed its perch on the cliff frequently, doing small aerial circuits before re-alighting, sometimes flying up into small crevasses, clinging there briefly, and flying out again. Flushed birds which were unsuccessfully chased included a Rock Pigeon (*Columba guinea*), Redwinged Starling (*Onychognathus morio*) and two smaller birds. 'Flush-hunting' was also observed being used by the female peregrine at Site 2. In this case she flushed, but failed to catch, a Rock Pigeon. This method was frequently used by immature peregrines in the Aleutian Islands, Alaska, and by adults in Argentina (C.M. White, pers. comm.).

The non-incubating bird's frequent absences from the nest-cliff may have been for the purpose of hunting. These absences lasted, on average, about 2 h (respectively, $\bar{x}/s.d.$; range, for male: 2 h 8 min/55 min; 1 h - 3 h 40 min; $n = 9$, and female: 1 h 50 min/1 h 30 min; 33 min - 4 h 1 min; $n = 7$). On at least 2 occasions returning birds had bulging crops.

Prey — Prey data from 3 Transvaal peregrine eyries are given in Table 2. These include items identified from plucking found below perches on the nest-cliffs (18), prey observed being caught (3) and potential prey unsuccessfully chased (7). In all cases prey was avian, and in the wt.-range 25-300 g. Thirteen (46%) were pigeons and doves. The sample from Site 3, a low veld eyrie, includes several bird-species which are absent from the escarpment region.

DISCUSSION

Of special interest was the high proportion of incubation done by the male (35%) and independence of the female in obtaining food during incubation. This compares with the findings of Hustler (1983) in Zimbabwe. In some peregrine populations (e.g. in Alaska, Enderson *et al.* 1972) males may share up to a third of the incubation, but it is usual for females to take the major share (Cramp 1980). The independent hunting by the female at

Site 1 is exceptional, since other studies indicate that she is provided with most or all of her food by the male during incubation (Brown and Amadon 1968; Cramp 1980). It would be instructive to determine whether these observations reflect an isolated occurrence or occur generally in populations of *F.p. minor*.

These two features are at variance with a general pattern in falconiforms where reversed size dimorphism is closely correlated with rapaciousness, a difference in prey size taken by the sexes and often with the nature of parental roles (Selander 1966; Reynolds 1972; Amadon 1975). Thus bird-catching hawks which are the most rapacious tend to have the greatest size dimorphism, take prey in 2 size-classes according to sex and, during breeding, partition parental duties such that the female does most of the incubation while the male does most or all of the provisioning (Newton 1979). Peregrines have a large size dimorphism and are highly rapacious, yet the observations recorded here do not conform to the predicted model of partitioned parental roles. The behavior of the pair at Site 1 may have been atypical.

The rarity of the peregrine in the Transvaal (and elsewhere in southern Africa) has not yet been adequately accounted for. The Lanner Falcon, by contrast, is a relatively common bird (McLachlan and Liversidge 1978). A measure of the relative abundance of the two species in the Transvaal is shown by the number of breeding sites of each recorded during the survey of birds of prey during 1975-1981 when 14 peregrine and 151 lanner eyries were located (Tarboton and Allan 1984). I believe that indirect competition between the two species is partly responsible for the peregrine's rarity, and that the following contribute to this situation:

(1) Prey — Whereas peregrines take almost exclusively avian prey, lanners, that prey largely on birds, also take a variety of non-avian prey, including rodents, bats, lizards and locusts (Brown and Amadon 1968; Cramp 1980, pers. obs.).

(2) Hunting Methods — The peregrine is a specialized hunter, securing avian prey in the air by stooping on it at great speed, and it requires sufficient air-space in order to chase and catch its prey. The lanner often hunts by stooping, but also hunts from perches and frequently chases avian prey in level flight, pursues prey flushed by vehicles, animals or persons on foot, and snatches prey such as

young gamebirds and poultry from the ground (Brown and Amadon 1968; Cramp 1980, pers. obs.).

(3) Nest-sites — All 14 Transvaal peregrine eyries were on high cliffs (mean height 187 m), only one being on a cliff lower than 140 m. Most recorded lanner nest-sites in the Transvaal ($n = 175$) were similarly on cliffs (57%), but mainly on small cliffs (45%) less than 60 m in height. Many were also in crow nests on pylons (25%), on crow or eagle nests in trees (14%), and on buildings or in quarries (4%).

Lanners, with a broad feeding niche, may outperform peregrines (on an energy/time-cost basis) in some situations, while in other situations the opposite will occur. During breeding, when food demands are greatest, this difference between the two species will reflect their choice of breeding sites and their reproductive output. It is predicted that optimal breeding sites for peregrines will be on high cliffs overlooking airspace through which there is a steady passage of high-flying birds within striking range. In such situations a breeding pair can search for prey while perched on the nest-cliff and simultaneously be able to defend the nest from predators. Lanners, less specialized in making high-speed, long-range stoops, may not match the performance of peregrines breeding in such circumstances. However, on progressively lower cliffs (which offer peregrines a less effective striking height) or in situations where there is less prey passing within range of the cliffs, breeding sites become marginal for peregrines, and a threshold would be reached where lanners, with their wider prey range and more diverse means of taking prey, outperform peregrines.

Peregrines breeding at marginal sites may incur higher energy costs than those breeding at optimal sites; both hunting away from the nest-cliff (necessitating frequent climbing in order to make stoops) and transporting food back to the nest, may be more time and energy consuming. Such disadvantages could leave nests exposed to potential predators and may result in a reduced provisioning rate, affecting reproductive performance negatively. The site observed may have been marginal since most hunting was done away from the cliff, and once during the 5-day watch the cliff was left entirely unattended for 55 min. This may also be why the female hunted for herself during incubation.

Elsewhere in the world the peregrine's prefer-

ence for high cliffs has been noted (Hickey 1942; Ratcliffe 1962); and during the extirpation of *F. p. anatum* from northeastern America through pesticide contamination in the 1950's it was noted that the first eyries to be deserted were those on low cliffs, and the last to go were those on the highest cliffs (Hickey 1969). This supports the hypothesis that occupation of high cliffs has energy/time-cost benefits for peregrines breeding there. In areas where lanners (or other *Falco* species filling the 'lanner-niche') are absent, peregrines may occupy a wider range of breeding sites than otherwise, although the reproductive performance of pairs at marginal sites may not match that of pairs at optimal sites. Where lanners occur in sympatry, peregrines are excluded from many marginal sites by lanners because of the latter's more generalized hunting capabilities and efficiency at low sites.

Thus it is hypothesized that the rarity of peregrines in the Transvaal is the result of (1) the general scarcity of optimal breeding sites (i.e. high cliffs overlooking airspace offering sufficient prey-capture opportunities), and (2) the presence of lanners which outcompete them (on an energy/time-cost basis) and exclude them from marginal sites. Lanners are generally much more common, since by far the greater part of the Transvaal is a plateau with little or no relief. However, in parts of the Transvaal Escarpment Region where conditions favor peregrines, lanners are outnumbered by them. In one such area 4 peregrine eyries are known, compared with only 2 of lanners.

ACKNOWLEDGMENTS

I thank David Allan and Guggi Tarboton for help in all aspects of the fieldwork, the Department of Forestry for cooperation and provision of many facilities, and the Transvaal Division of Nature Conservation who supported this work.

LITERATURE CITED

- Amadon, D. 1975. Why are female birds of prey larger than males? *Raptor Research* 9:1-11.
- BROWN, L.H. AND D. AMADON. 1968. Eagles, hawks and falcons of the world, Vol. 2. Feltham: Country Life.
- CADE, T.J. 1969. The status of the Peregrine and other Falconiformes in Africa, pp 289-321, in Hickey, J.J. (ed) Peregrine Falcon populations, their biology and decline. Madison: Univ. Wisc. Press.
- CRAMP, S. 1980. Handbook of the birds of Europe, the Middle East and North Africa, Vol. 2. Oxford: Oxford Univ. Press.

- ENDERSON, J.H., S.A. TEMPLE AND L.G. SWARTZ. 1972. Time-lapse photographic records of nesting Peregrine Falcons. *Living Bird* 11:113-128.
- HERBERT, R.A. AND K.G.S. HERBERT. 1965. Behaviour of Peregrine Falcons in the New York City Region. *Auk* 82:62-94.
- HICKEY, J.J. 1942. Eastern populations of the Duck Hawk. *Auk* 59:176-204.
- HICKEY, J.J. (ED). 1969. Peregrine Falcon populations, their biology and decline. Madison: Univ. Wisc. Press.
- HUSTLER, K. 1983. Breeding biology of peregrine falcon in Zimbabwe. *Ostrich* 54: 161-171.
- McLACHLAN, G.R. AND R. LIVERSIDGE. 1978. Roberts' birds of South Africa, 4th ed. John Voelcker Bird Book Fund: Cape Town.
- Macworth-Praed, D.W. and C.H.B. Grant. 1957. Birds of eastern and northeastern Africa, Ser. 1, Vol. 1. London: Longmans.
- Macworth-Praed, C.W. and C.H.B. Grant. 1962. Birds of the southern third of Africa, Ser. 2, Vol. 1. London: Longmans.
- NEWTON, I. 1979. Population Ecology of Raptors. Buteo Books, Vermillion, South Dakota.
- RATCLIFFE, D.A. 1962. Breeding density of the Peregrine *Falco peregrinus* and Raven *Corvus corax*. *Ibis* 104:13-39.
- REYNOLDS, R.T. 1972. Sexual dimorphism in the accipiter hawks: a new hypothesis. *Condor* 74: 191-197.
- SELANDER, R.K. 1966. Sexual dimorphism and the differential niche utilization in birds. *Condor* 68:113-151.
- SIEGFRIED, W.R., P.G.H. FORST, J. COOPER, AND A.C. KEMP. 1976. South African Red Data Book: Aves. *S. Afr. National Sci. Prog. Rep.* 7. Pretoria: CSIR.
- SNOW, D.W. (ED). 1978. An atlas of speciation in African non-passerine birds. London: Trustees Brit. Mus. (Nat. Hist.).
- TARBOTON, W.R. AND D.G. ALLAN. 1984. A survey of birds of prey in the Transvaal. Tvl. Mus. Monogr. No. 3.

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Received 15 August 1982; Accepted 15 august 1983

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ROOST SELECTION AND BEHAVIOR OF THE LONG-EARED OWL (*Asio otus*) WINTERING IN NEW JERSEY

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ABSTRACT - Roosting Long-eared Owls (*Asio otus*) selected conifers with dense foliage that concealed all or most of the main trunk with no apparent regard to tree species. Roosts were established only in clumps of 2 or more closely-spaced conifers (3-15 m in height), always near a variety of open habitats. Communal roosts of 2-4 owls were significantly preferred to solitary roosts. Strong fidelity for a single roosting tree was observed within each winter, although the owls shifted to a new main roost site each yr. Owls concealed themselves in dense foliage; when approached, they would hide or freeze and flush only at close distances. Evidence indicated that these owls had habituated to remarkably close human activity, although they were readily able to detect an intruder. The 2 most frequented roosts were within 8 m of large buildings which may have provided wind protection and increased shade for hiding. The owls remained at roosts well into darkness and when flushed during the day, showed strong aversion to daylight activity.

While the food habits of wintering Long-eared Owls (*Asio otus*) have been extensively studied (see reviews by Marti 1976; Voight and Glenn-Lewin 1978), the literature on roosting sites and attendant behavior is limited and few of the observations have been systematic (Glass and Nielsen 1967; Smith 1981). Here, I document systematic counts of roosting Long-eared Owls in man-made habitat where all vegetation was landscaped and planted in orderly patterns (i.e., an industrial park and a cemetery). This eliminated many of the habitat variables normally encountered in natural ecosystems and facilitated the identification of essential roost-site requirements.

STUDY AREA AND METHODS

Observations on roosting Long-eared Owls were made from 18 January 1981 to 10 March 1984 in the Hackensack Meadowlands District, New Jersey. This area contains estuarine marshes that border the lower Hackensack River. These extensive open marshes are dominated by common reed (*Phragmites communis*), interspersed with small tidal channels and creeks. Ornamental conifers were distributed in a nearby industrial park (office and warehouse buildings).

In 1981, all conifers within 1 km of the originally-discovered roost were checked for owls and/or their sign (pellets, prey remains, feathers, urates). I found that all roosting activity was limited to one 22 ha block of the industrial park. In 1982, I systematically searched this block for roosting owls with 9 flush counts (Craighead and Craighead 1956), by closely inspecting 77 conifers on each census date. These conifers were 2-6 m high and were the following: 73 Austrian pine (*Pinus nigra*), 2 eastern hemlock (*Tsuga canadensis*), and 2 Atlas cedar (*Cedrus atlantica*). The number of flush counts was kept to a minimum and their timing was designed to obtain the most information with the least amount of disturbance to the owls (Table 1). At approximately monthly intervals, other conifers within 1 km were checked but signs of roosting were not revealed. After the snow cover had melted in early February of 1982, pellets were found and collected on each of the last 6 flush counts. A record of the number and location of pellets provided an additional measure of roost-site

use, for each owl ejects approximately 1 pellet per day at the roost (Craighead and Craighead 1956; Birkenholz 1958; Graber 1962). Analysis of these pellets was reported previously (Bosakowski 1982). During the winter of 1982-83, neither owls nor pellets were found during 17 systematic searches. In the winter of 1983-84 the roosts became active again and 9 systematic searches (including pellet collections) were conducted.

RESULTS AND DISCUSSION

Roost Trees. — In the study block, I observed Long-eared Owls roosting in 4-6 m ornamental Austrian pines (36 times) and once in a 2 m hemlock. A few additional observations were made at a cemetery about 2 km from the study block during the second winter. Here, 1-3 Long-eared Owls roosted in a planted row of 4-5 m ornamental arborvitae (*Thuja* spp.) and in a row of 10-15 m hemlocks. Although Long-eared Owls typically exhibit a strong preference for roosting in conifers, a preference for certain species has not yet been indicated (Randle and Austing 1952; Smith 1981; this study). Density of foliage is probably of most importance since it provides protection from wind-chill, precipitation, predators, and mobbing birds. In this study the trees selected for roosting were those that offered the greatest foliage density and concealment of the main trunk. Smith (1981) noted that roost trees had extensive branching to within 2 m of the ground.

Roost-site Use and Characteristics. — In the study block, virtually all roosting was confined to 2 roost sites (Fig. 1). In 1981, the owls showed a strong fidelity for roost 1 as demonstrated by the lack of sightings and pellets elsewhere in the study area. In 1982, 1 or 2 owls stayed in roost 1 for a short period (10 pellets) and joined other owls (maximum = 3) at roost 2 for the remaining winter

Table 1. Systematic flush counts of Long-eared Owl roosts.

DATE		ROOST 1		ROOST 2	
		OWLS	PELLETS	OWLS	PELLETS
First Winter					
20 January	1981	1	+ ^a	0	0
31 January	1981	2	+	0	0
Second Winter					
01 January	1982	0	0	0	0
24 January	1982	1	NC ^b	3	NC
26 January	1982	2	NC	1	NC
04 February	1982	0	10	3	85
10 February	1982	0	0	3	15
23 February	1982	0	0	3	9
02 March	1982	0	0	1	8
18 March	1982	0	0	1	14
24 March	1982	0	0	1	1
Third Winter ^c					
31 October 1982- 4 April 1983		0	0	0	0
Fourth Winter					
18 December	1983	0	0	0	0
31 December	1983	4	27	0	0
07 January	1984	0	26	0	0
20 January	1984	4	NC	0	NC
28 January	1984	3	52	0	0
04 February	1984	2	25	0	0
20 February	1984	2	32	0	0
04 March	1984	0	1	0	0
10 March	1984	1	3	0	0
Totals:		22	176+	15	132

^apellets present but not collected during first winter.^bpellets not collected because of snow cover.^ca total of 17 counts were made during this period.

(132 pellets) (Table 1). In 1983 there was no evidence of roosting during the entire winter season. This may have been the result of mild temperatures during December and January as compared to other years (Fig. 2). In 1984 only roost 1 was used by 1-4 owls.

Roost 1 consisted of a cluster of two 4 m Austrian

pinces that were 2 m apart, three 1 m evergreen shrubs, a 2 m hemlock, and a 6 m white birch (*Betula pendula*). The trees were planted on a 0.5 m mound, bordered with small boulders. Roost 2 was a row of ten 3-5 m Austrian pinces that were planted so that the foliage met between almost every tree. The preference of Long-eared Owls to select roost trees

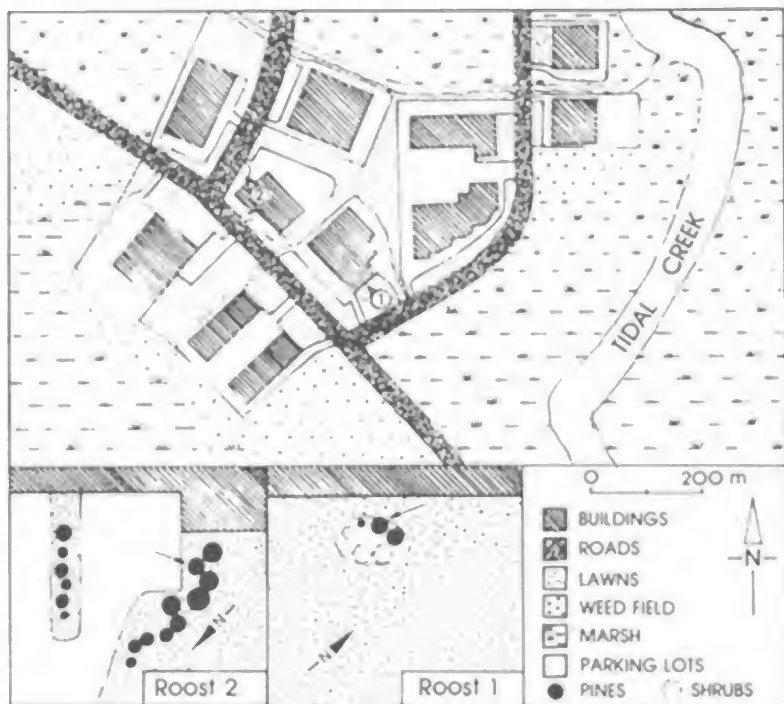


Figure 1. Map of study area with inset maps showing close-up views of two Long-eared Owl roosts. Small arrows indicate most frequently-used roost trees. Systematic searches were conducted in the center block (study block).

from among clumps of two or more conifers was also noted by Bent (1938:153), Randle and Austing (1952), and Birkenholz (1958).

The two roosts that were selected represented 2 of 4 apparently-suitable pine plantings in the study block, yet the other pine groups showed virtually no signs of use during the study (2 and 6 pellets found). The two favored sites were closer to buildings (6-8 m as compared to 19-25 m) and as a result, received less direct sunlight. Protection from the prevailing northwesterly winds was apparent at roosts 1 and 2 but not at the little used pine groups. While the eastern site (roost 1) was shielded directly by the adjacent building, the western site (Roost 2) was also protected by being on the southeastern side of the pine row (Fig. 1).

Roost-site Fidelity. — The fidelity of Long-eared Owls to certain trees within the favored roost sites was evident, e.g., in 1982 there were 119 pellets under one tree in roost 2 and only 27 pellets under 7 additional trees. In 1984 the results were similar

at roost 1 with 147 pellets under 1 tree and 67 pellets under 9 other trees. Some pellets found at alternate roost trees were the result of owls temporarily moving after I flushed them. The Craigheads (1956:88) mentioned the habit of Long-eared Owls to return to the same roost tree and noted one owl on the same perch on 9 consecutive roost counts. I observed 1-3 owls roosting in the same tree on 7 consecutive roost counts (54-day period). Smith (1981) reported the fidelity of Long-eared Owls to certain groups of trees over a period of many years, but no reference was made to fidelity to individual trees.

While I observed a strong fidelity to one roost site during each winter, it was surprising that the owls established their main roost at a different site each year, alternating between roost 1 and roost 2 (Table 1). These data seem to indicate that the initial selection between two suitable roosts is a rather fortuitous event and that a strong site-tenacity develops thereafter. Similarly, Klopfer and Hailman

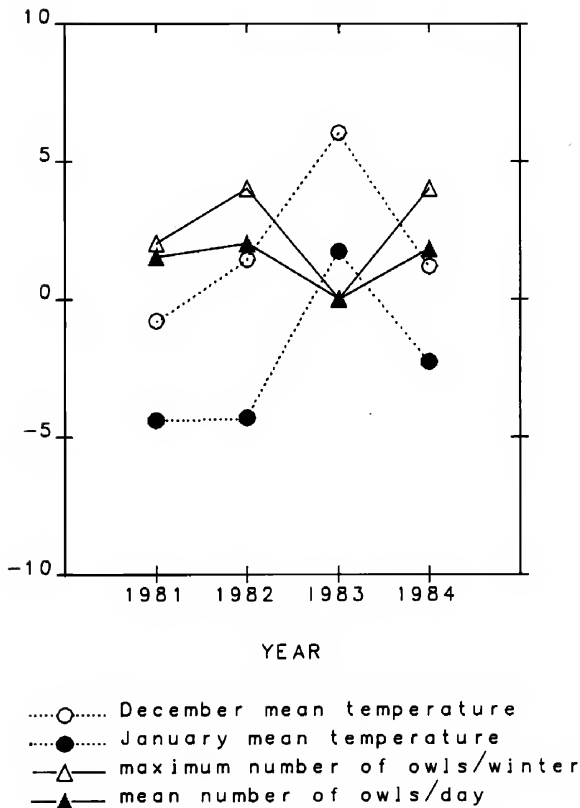


Figure 2. Inverse relationship between mean winter temperatures (°C) and owl numbers occurring in the study area. Weather data was obtained from National Weather Service at Newark International Airport located only 13 km from the study site.

(1965:291) have postulated that in their study only one of several available sites was occupied by gulls because of social stimulation.

Proximity to Hunting Areas. — According to the literature, Long-eared Owl roosts are almost always located near open habitats. The significance of this association was revealed by Randle and Austing (1952) who found a "preponderance" of open-field prey species in the pellets. A review of numerous food habits studies (Marti 1976) confirms this finding and suggests that the majority of hunting occurs in open country. In the present study, both roosts were within 200 m of large *Phragmites* tidal

marshes. In addition, five man-made habitats were also present: a few small weed-covered fields (total 15 ha), 2 bulldozed construction sites (8 ha), parking lot and road edge, lawns surrounding the roosts, and large sanitary landfill mounds (70 ha). Hunting in these "disturbed" habitats may have accounted for the unusual dominance of *Mus musculus* in the pellets (Bosakowski 1982).

Roosting Behavior. — In most cases owls concealed themselves completely in a dense portion of the conifer and were not visible until flushed or an intention movement was made. Consequently, it was not always possible to accurately note information such as roosting height, distance from trunk, or individual distances.

On one occasion, a Long-eared Owl was perched on a completely exposed branch, but when I approached, it hopped along several branches and hid behind the tree trunk while keeping a continuous watch in my direction. Similar hiding behaviors were observed on 3 other roost counts. On 2 other occasions, owls were seen trying to avoid detection by elongating their posture, erecting their ear tufts and closing their eyelids nearly completely. The resultant motionless form was maintained unless I approached closer than 3-4 m; then the owls flushed. This concealing posture was identical to the "broken branch" appearance described in Bent (1938:163). Another time, I observed a person, unaware of the owl roost, walk within 4 m of an owl that was roosting on an exposed branch, but the owl remained undisturbed. However, when I approached within 9 m and looked directly at the same owl, it began staring intently, quickly rotated its head back and forth, and then flushed. These contrasting observations suggest that Long-eared Owls will habituate to nearby human traffic, but are readily able to discriminate when they are being watched. Such selective attention to a predator's eyes (in this case, the author's) can have considerable survival value (Suarez and Gallup 1983) in that prey species can monitor the direction of a predator's visual focus and may be able to take advantage of better escape opportunities (Gagliardi et al. 1976). Randle and Austing (1952) reported a similar ability of Long-eared Owls to discern scattered members of a searching party and change the direction of their escape flight accordingly.

Communal Roosting. — In general, these owls roosted or flushed between 2 to 3 m above ground. When 2-4 owls roosted communally, they were

typically distributed on different branches at varying heights. Only once were 2 owls seen roosting together on the same branch. When more than one owl was present in the study block, communal roosting was significantly preferred ($\chi^2 = 18.0$, d.f. = 1, $P < 0.001$) with only 4 solitary roostings observed. Fleming (1981) lists the five most accepted explanations for communal roosting: (1) a shortage of roost sites, (2) huddling for body heat conservation, (3) predation risks, (4) a tendency to exchange information on patchy food locations, and (5) to assess population size in relation to resources. Although suitable roost sites were not plentiful in the study area (hypothesis 1, Fleming 1981) my data show that a major roost can be totally ignored in successive years with the owls clustering at another nearby site. Clustering is not related to huddling (hypothesis 2, Fleming 1981), for the closest individual distance observed was 0.4 m. Reduction of predation risks (hypothesis 3, Fleming 1981) has probably been a major 'ultimate' factor in favor of these owls forming communal assemblages. During many flush counts, one owl would usually detect me first, and then the others apparently were alerted by either intention movements or by the sound of the first bird flushing. Furthermore, when several owls flush simultaneously, momentary confusion may be experienced by an advancing predator. Post (1983) speculated that in a solitary hunting species, communal winter roosts have probably evolved as an anti-predator mechanism. However, hunting by Long-eared Owls may not be a completely solitary event since some owls may follow others to profitable hunting grounds. Therefore, the effect of hypothesis 4 (Fleming 1981) remains unknown for the Long-eared Owl. Finally, I agree with Schnell (1969) that the plausibility of hypothesis 5 (Fleming 1981) is questionable and not likely to be tested in the field.

Flushing Behavior. — The view of the owls was frequently obstructed by dense cover or they were dozing with closed or partially closed eyes. Hence the flushing distance was usually between 2 to 4 m with a quiet approach (no crusty snow or leaves). During the study period, the owls were flushed a total of 22 times, either singly or in groups. On 8 occasions, some owls immediately returned to the same roost site within a period of several min. Two owls attempted to return repeatedly (4 and 6 times) to the same roost tree within 10 min of being flushed. Apparently disturbed by my presence,

these owls were unable to resettle at each return. This reluctance to leave the roost has not been previously described, but was probably related to the scarcity of roosting cover in the study area. Owls that did not attempt an immediate return to the roost were generally seen perched in the nearest available conifers. This further attested to the strong aversion of Long-eared Owls for daylight activity. Like the observations of Randle and Austing (1952), the owls I studied were often clumsy and disoriented when flushed, and twice were observed to fly into black non-reflective windows of an adjacent building. Apparently, the dark windows were mistaken for large cavities. No injuries were evident and the owls continued to seek cover immediately. The tendency of Long-eared Owls to hide, freeze and flush only at close distances explains why this raptor is able to roost very close to human habitations.

Roost Departure. — The nocturnal inclination of the Long-eared Owl was further characterized by their late emergence at dusk. On 2 evenings, owls were still roosting 26 and 40 min after sunset at roost 2, but on 2 other evenings, could not be found at this roost 49 or 81 min after sunset. From these 4 evenings, it appears that roost departure is most likely to occur between 40 and 49 min after sunset. Similarly in England, Armitage (1968) observed a group of Long-eared Owls on one night departing from the winter roost 35 min after sunset. In Denmark, Glass and Nielsen (1967) observed departures of Long-eared Owls from a winter roost on 40 nights and found a departure time of 39 ± 8 ($\bar{x} \pm S.D.$) min after sunset.

ACKNOWLEDGMENTS

I thank Robert Speiser and Richard Kane for valuable discussions throughout the course of the study and for their critical reading of the manuscript. Appreciation is also extended to Drs. John H. Edgcomb, Frances N. Hamerstrom, Kevin L. Keim, Carl D. Marti, and Clayton M. White for reviewing various drafts of the paper. Robert Pitler provided encouragement and suggestions about the project. Dr. Arthur A. Levin assisted with graphics.

LITERATURE CITED

- ARMITAGE, J.J. 1968. A study of a Long-eared Owl roost. *Naturalist* No. 905:37-46.
- BENT, A.C. 1938. Life histories of North American birds of prey. *U.S. Natl. Mus. Bull.* 170:482 pp.
- BIRKENHOLZ, D. 1958. Notes on a wintering flock of Long-eared Owls. *Ill. Acad. Sci. Trans.* 51:83-86.

- BOSAKOWSKI, T. 1982. Food habits of wintering *Asio* owls in the Hackensack Meadowlands. *Records of N.J. Birds* 8:40-42.
- CRAIGHEAD, J.J. AND F.C. CRAIGHEAD, JR. 1956. Hawks, owls and wildlife. Stackpole Co., Harrisburg, Pa.
- FLEMING, T.H. 1981. Winter roosting and feeding behavior of Pied Wagtails *Motacilla alba* near Oxford, England. *Ibis* 123:463-476.
- GAGLIARDI, G.J., G.G. GALLUP, JR., AND J.G. BOREN. 1976. Effect of different pupil to eye size ratios on tonic immobility in chickens. *Psychonomic Science* 8:58-60.
- GLASS, M.L. AND T.H. NIELSEN. 1967. The evening departure of the Long-eared Owl (*Asio otus*) from the winter roost. *Dansk. Ornithol. Foren. Tids.* 61:100-106.
- GRABER, R.R. 1962. Food and oxygen consumption in three species of owls (Strigidae). *Condor* 64:473-487.
- KLOPFER, P.H. AND J.P. HAILMAN. 1965. Habitat selection in birds. In: *Advances in the study of behavior*. (Eds. D.S. Lehrman, R.A. Hinde, and E. Shaw). Vol. 1, Academic Press, New York.
- MARTI, C.D. 1976. A review of prey selection by the Long-eared Owl. *Condor* 78:331-336.
- POST, W. 1982. Why do Grey Kingbirds roost communally? *Bird Behavior* 4:46-49.
- RANDLE, W. AND R. AUSTING. 1952. Ecological notes on Long-eared and Saw-whet Owls in southwestern Ohio. *Ecology* 33:422-426.
- SAUREZ, S.D. AND G.G. GALLUP, JR. 1983. Emotionality and fear in birds: A selected review and reinterpretation. *Bird Behavior* 5:22-30.
- SCHNELL, G.D. 1969. Communal roosts of wintering Rough-legged Hawks (*Buteo lagopus*). *Auk* 86:682-690.
- SMITH, D.G. 1981. Winter roost site fidelity by Long-eared Owls in central Pennsylvania. *Amer. Birds* 35:339.
- VOIGHT, J. AND D.C. GLENN-LEWIN. 1978. Prey availability and prey taken by Long-eared Owls in Iowa. *Am. Midl. Nat.* 99:162-171.
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Received 6 September 1984; Accepted 21 January 1985

FACTORS INFLUENCING DIFFERENTIAL PREDATION ON HOUSE MOUSE (*Mus musculus*) BY AMERICAN KESTREL (*Falco sparverius*)

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ABSTRACT - Due to the sexual size dimorphism of raptors, it was thought that a preference for different sized prey might be evidenced between male and female American Kestrel (*Falco sparverius*). A modified bal-chatri trap was used which gave kestrels a choice of 2 types of mice. In the first experiment, wild birds in the field were given a choice between a large mouse (35 - 40g) and a small mouse (22 - 27g). The results of the summer season were compared to those of the fall-winter season. The preferred prey size between the males and the females was not significantly different in fall-winter ($X^2 = 0.036$, $P > 0.05$). During breeding season, the preferred prey size shifted dramatically; males chose predominately small mice, females predominately large ones ($X^2 = 20.55$, $P < 0.001$). The second experiment showed the influence of hunger on preference for a particular sized mouse. The birds that were determined to have a higher hunger level chose predominately the large mice ($X^2 = 5.18$, $P < 0.025$). The third experiment showed the effect of a conspicuous, but odd, color of prey (white mouse) compared to that of the normal, agouti color. The agouti color was chosen by 82% of the birds. The difference between the actual preference and a random choice was highly significant ($X^2 = 18.85$, $P < 0.005$).

There are many aspects to the selection of prey by predators. Lack of protective coloration (Dice 1947; Kaufman 1974a), prey activity (Kaufman 1974b) and oddity (Mueller 1971) play important roles. The roles of predator experience (Mueller and Berger 1970), specific search image (Tinbergen 1960; Mueller 1971) and hunger (Mueller 1973) have also been demonstrated. Several authors have investigated the role of size in the selection of prey by storks (Ogden et al. 1976), shrikes (Slack 1975) and several species of raptors (Storer 1966; Mueller and Berger 1970; Synder and Wiley 1976; Marti and Hogue 1979).

The American Kestrel (*Falco sparverius*) shows only a slight size dimorphism with the male being, on the average, 8% smaller by weight than the female (Brown and Amadon 1968). The kestrel must select prey with an efficiency such that the energy expended to find, catch and kill the prey is less than the energy obtained. Predation efficiency is even more important during the breeding season when the male feeds the female and young, as well as himself. Certain prey must exist that are more efficiently found and subdued (Emlen 1968). One aspect of this efficiency is size of prey. This study attempts to show a preferred size of prey by kestrels which corresponds to the sex of the bird, hunger of the bird and color of the prey, as well as seasonal variation.

METHODS AND MATERIALS

A modified bal-chatri trap (Mueller and Berger 1959), consisting of 2 compartments (each 13 cm x 25 cm) separated by 15 cm and made of 1/2-in hardware cloth was used. Capture loops were made using 12# + cst monofilament line with approximately 20 loops attached to each compartment. Two size categories of the agouti colored House Mouse (*Mus musculus*) were used: large (35-40g) and small (22-27g). All agouti mice were inbred genetic

strain C2H. Small mice were randomly placed in 1 cell and large in the other. Whenever possible, the 2 mice used had a 15g weight difference. When a perched kestrel was sighted the trap was tossed to the ground from a slowly moving vehicle at a distance of 10-40 m from the bird. The trap was removed after 5 min unless some type of response from the kestrel was observed. When the bird was trapped, its sex was noted as well as which mouse (large or small) it attacked. Any time a bird switched from one side of the trap to the other, the trial was discounted. This happened on only 10 of 149 trials and only in the fall-winter season. The fall-winter season included the months September, October, November and December 1980 & 1981. No switches were made during the summer season of May, June and July, 1981, 1982, 1983 (see Tables 1 and 2). Males and females were compared for prey size preference as well as difference between the 2 seasons. Independent and semi-independent young birds were separated from adults on the basis of whether flight feather molt was occurring during the breeding season (see Table 2). During fall-winter season the immature birds were combined with the data for adults.

A second part of the study concerned the determination of hunger in birds which might have influenced preference for a particular sized mouse. Hunger was determined by computing ratio of average wing chord to the cube root of average body wt. Any bird with a ratio above the average was considered underweight and any bird with a below average ratio was considered overweight. Overweight and underweight kestrels were then sub-

Table 1. Comparison of the number of female and male kestrels that chose either the large or the small mouse during the fall-winter "season". The category "switched mice" denotes that the kestrel attacked one size mouse and then switched and attacked the other.

	LARGE MOUSE	SMALL MOUSE	SWITCHED MICE
Males	23	26	4
Females	41	49	6

Table 2. Comparison of the number of female and male kestrels that chose either the large or the small mouse during the "summer" season. The category "switched mice" denotes that the kestrel attacked one size mouse and then switched and attacked the other.

	LARGE MOUSE	SMALL MOUSE	SWITCHED MICE
Males	5	23	0
Females	21	4	0
Immature			
Females	3	10	
Immature			
Males	1	1	0

jected to Chi-square (X^2) analysis to determine if both preferred the same or different sized mice.

Finally, I determined if a conspicuous, but odd-colored, mouse (white) was preferred over the more natural color (agouti). The white mouse could be seen, when it moved, up to approximately 300 m away, whereas the agouti mouse could be seen up to approximately 200 m. These distances were determined by objective analysis by the author. The background did not appear to make much difference in discerning the white mouse unless the substrate was very light in color. The experiment was similar to the large and small mouse experiment, except the trap contained only 1 white and 1 agouti mouse with no more than 3 g difference in wt.

Comparison of wing chord was done between summer and fall-winter kestrels to determine if 2 populations of kestrels (migratory and non-migratory) were being sampled in fall-winter versus 1 population in summer (non-migratory). A t-Test was used to compare means and a F-test for variance.

RESULTS AND DISCUSSION

Fifty-three adult birds were trapped during the summer season when young were in the nest or still on the territory being fed. In the fall-winter season 1980 and 1981, 149 birds were trapped. Eighty-nine birds were trapped for the white mouse/agouti mouse experiment in the fall-winter season, 1982 and in January 1983. Kestrels were trapped in open habitat in Los Angeles, Orange, Riverside and Kern counties, southern California. During fall-winter, more females were trapped than males. This may have been due to sexual habitat preference (Koplin 1973). Females tend to prefer open habitat while males prefer woodland margins.

The data are shown in Tables 1-5. The preferred prey size between males and females was not significantly different in fall-winter ($X^2 = 0.036$, $P > 0.05$; see Table 1). During the breeding season, preferred prey size shifted dramatically; males

predominately chose small mice, females predominately large mice (see Table 2). This difference was highly significant ($X^2 = 20.55$, $P < 0.001$) and was reflected in seasonal comparisons within each sex. Males shifted from a random choice in fall-winter to a strong preference for small mice in the breeding season ($X^2 = 5.32$, $P < 0.025$). Females shifted from a random choice in fall-winter to a strong preference for large mice in the summer season ($X^2 = 10.14$, $P < 0.001$).

Table 3. The number of overweight and underweight females that chose either the large or small mouse during the fall-winter "season".

	LARGE MOUSE	SMALL MOUSE
Overweight	12	13
Underweight	11	13

Relationship of hunger to preferred prey size was apparent with females. During the fall-winter, underweight females predominately chose the large mouse while overweight females chose the small mouse (see Table 3). This difference in the preferred prey size was significant ($X^2 = 5.18$, $P < 0.025$). However, there seemed to be no relationship of hunger to preferred prey size in males ($X^2 = 0.018$, $P > 0.05$) (see Table 4). Average wing chord for 49 males and 90 females was 188 mm and 196 mm, respectively. Wing chord means and variance values did not differ significantly from summer to fall-winter seasons (t-Test, $P > 0.05$; F-test, $P > 0.05$). Average weight was 108 g for males and 122 g for females.

Table 4. The number of overweight and underweight males that chose either the large or small mouse during the fall-winter "season."

	LARGE MOUSE	SMALL MOUSE
Overweight	12	13
Underweight	11	13

Effect of a conspicuous, but odd, color of prey (white mouse) is seen in Table 5. There was no significant difference between male and female selection for color ($X^2 = 0.272$, $P > 0.05$), therefore they were combined. Eighty-two percent of kestrels chose agouti mice. The difference between the actual preference and a random choice was highly significant ($X^2 = 18.85$, $P < 0.005$).

Table 5. The number of males and females that chose either the white or agouti colored mouse during the fall-winter "season". The category "switched mice" denotes that the kestrel attacked one size mouse and then switched and attacked the other.

	WHITE	AGOUTI	SWITCHED MOUSE
Males	4	26	1
Females	12	47	2

Behavior of kestrels toward the trap led me to believe that each bird was preferentially selecting one of the mice. The kestrels exhibited several types of behavior. In one type the bird flew toward the trap and hovered over it for several seconds before attacking one side. In another pattern the kestrel flew to a position over the trap (telephone lines or poles, trees, etc.) and sat examining the trap for some time before attacking. In the third, and most convincing, type of behavior, the bird was not caught on initial attack, flew away, and consistently returned to attack the same mouse. This pattern continued until the kestrel either was caught or gave up. In the last, the bird attacked one side of the trap, then attacked the other or it attacked one side, flew away, and returned to attack the other. This was rare, occurring 6.7% of the time, during fall-winter and was excluded from data analysis.

The results clearly show a preference for size of prey in spring for kestrels. The reasons for this preference are not as clear. The first possible reason was advanced by Storer (1966). He hypothesized that due to sexual size dimorphism, sexes take different size prey serving to reduce competition between them so that the pair can feed in a smaller territory. This may work well when the prey is birds. Young birds (after fledging) are essentially

the same size as adults, so preying on different size birds means preying on different species. This would seem to reduce competition between sexes and increases the number of potential prey. However, in rodent species young are smaller than adults. Preying on different sizes (hence difference ages) of the same species would not seem to increase available prey, although it would allow some reduction in competition between sexes. If male and female kestrels prey on different sizes of the same species, the prey population would be reduced as quickly as if both sexes preyed on both sizes equally. This hypothesis should not be quickly discarded, however, as even a subtle avoidance of competition is an advantage.

An alternative is that males chose the smaller mouse because there are simply more small mice at that time of the year. The males may have formed a specific search image (SSI) for smaller mice on the basis of availability. The females, on the other hand, do little hunting for much of the season and may not have a strong SSI formed and thus choose the larger mouse for a larger reward.

Another alternative deals with the energetics of carrying a mouse to the nest cavity. The female does little hunting for most of the breeding season while the male procures food for himself, the female and young. He must carry prey to the nest for distances up to 1 km (Balgooyen 1976). It may be less energetically demanding to carry more small mice to the nest than fewer large mice. The female, on the other hand, hunts infrequently near the nest, and does not have far to carry prey; therefore, it seems most advantageous for her to attack the largest prey possible. Studies of the energetics of flying with varying weights are needed to confirm this hypothesis.

During winter, the males and females are feeding only themselves and would not need to be as selective with the size of prey. The prey does not have to be carried far and both sexes should be able to kill the large category mouse with almost equal skill. Males do not have the same bulk as females, however males do have a lighter wingloading and feet and beaks which are not significantly different in size (Balgooyen 1976). The male should be able to transport prey as easily as the female due to lighter wingloading. The only advantage seems to be that females have more bulk to subdue larger prey. A flaw in this hypothesis is that it would seem most advantageous to prey on the largest mouse because

of the larger gain. This was not, however, indicated by the data. The birds selected a large proportion of small mice in winter. This may be explained by the hunger of the bird. A kestrel that is underweight might be more inclined to attack a larger mouse than a kestrel that is overweight.

The influence of hunger in predation was shown by Mueller and Berger (1970). They trapped Sharp-shinned Hawks (*Accipiter striatus*) in 2 manners. One in which the hawks actually struck lure birds [pigeons, starlings or House Sparrows (*Passer domesticus*)], and the other in which the hawks flew near, but did not attack, and were trapped in a net. Although the data were not statistically significant in all cases, a tendency existed in which lighter hawks actually struck prey more frequently. This suggested to them that hunger influences a hawk's tendency to kill. Mueller (1973) demonstrated the relationship of predatory behavior to hunger in American Kestrels. Kestrels were deprived of food for intervals of 1, 5, 10, 20, 25, 30 or 35 h. In his experiment on deprivation interval to food consumption the curve was almost linear. On the average, kestrels consumed 2% of their body wt after 1 h of deprivation and about 13% after 35 h. In the experiment on deprivation interval to killing tendency the curve was only a little less linear. After 1 h of deprivation kestrels killed mice 14% of the opportunities and 92% after 35 h. Mueller (1973:519) felt that all his data "indicate a complete correlation between food consumption and predatory behavior, suggesting that predation is a direct response to hunger."

In this paper it was assumed that an underweight bird is more hungry than an overweight bird. The effect of hunger is seen in Tables 3 and 4. Table 3 shows the effect of female hunger in which 32 of 48 (67%) of the overweight females chose the large mouse. Table 4 shows this not to be the case with males. There is no difference in preferred prey size from underweight to overweight males. There may be other factors that override the effect of hunger in males. The data for females suggest that hunger influences the selection for prey, which is contrary to Lorenz's (1966) generalization that killing instinct of predators is unitary and driven independently of hunger. However, my study supports the contention of Mueller (1973) and Mueller and Berger (1970) that hunger plays an important role in the tendency to kill.

The results of the white mouse/agouti mouse ex-

periment clearly show a preference for the natural agouti color although there is a definite selection for the odd color (white) at times. This was especially evident when kestrels attacked the white mouse, was not caught, and returned to the same mouse before getting caught. The selection of agouti mice seems to show an SSI for agouti color whereas the selection of white mice may show a tendency of a kestrel to vary its diet (Tinbergen 1960; Mueller 1974). I believe the existence of an SSI is supported by this study, although there appear to be many variables that can alter the SSI. Several authors believe that predators carefully evaluate their chances of success with each prospective prey (Cushing 1939; Errington 1967; Cade 1967). When this evaluation encompasses the SSI, the predator will decide whether to attack or not (e.g., if the mouse is the correct size, color and species but the distance to the prey is too far and the cover is too dense, the bird will not attack).

The selection of odd mice in my experiment is consistent with the results of Mueller (1974:716) in which "some birds showed a tendency to select a reasonably constant proportion of mice of a given color throughout a series regardless of the relative abundance of the mouse, suggesting that the bird seeks a fixed amount of novelty or variety." Mueller contended that in most prey populations odd prey is probably unfit and, therefore, would be actively selected from the environment (see Mueller 1974 for a listing of references to support the contention).

There are inherent problems in any study that attempts to relate an artificial situation to the real world, and this study is no exception. A choice between 2 mouse sizes probably rarely occurs in nature and it seems unlikely that the kestrel would not kill a mouse of the non-preferred size. However, the birds probably have an SSI for a preferred size and when all factors are considered (i.e., distance from prey, visibility of prey, etc.) they are more likely to attack the preferred size than another. This does not mean that either sex will not attack the non-preferred size mouse. The kestrel is an opportunistic predator and will attack anything within certain broad limits. It does mean that they have an SSI for a size prey that they will aggressively pursue over long distances and more adverse conditions than other size prey. Another problem to consider is the activity of the 2 mouse sizes, as Kaufman (1974b) showed that active rats were

preyed upon more than inactive rats. Marti and Hogue (1979) found that small mice may move faster than large mice, but they do not move longer distances in the same time period. If the kestrels preferred a faster (smaller) mouse or a slower (larger) mouse, it would not be expected that they would switch this preference seasonally as is the case in this study.

A third potential problem is with fall-winter data which dealt with hunger in females where 2 populations of females were sampled (migratory and non-migratory). Although wing chord analysis showed no difference in the size of these 2 populations, it may be that migratory females are, on the average, lighter in wt than non-migratory females. Migratory females may have a previous SSI formed for large mice. This would bias the data toward the results achieved based on hunger. In the fall-winter data, part of the population were immature birds which were not distinguished from adults. Mueller and Berger (1970) showed that inexperienced raptors tend to take inappropriate prey. However, I have a strong feeling that by winter young birds have formed an SSI.

LITERATURE CITED

- BALGOOYEN, T.B. 1976. Behavior and ecology of the American Kestrel (*Falco sparverius*). *Univ. Calif. Publ. Zool.* 102:1-85.
- BOND, R.M. 1943. Variation in western Sparrow Hawks. *Condor* 45(5):168-185.
- BROWN, L. AND D. AMADON. 1968. Eagles, hawks and falcons of the world. McGraw-Hill.
- CADE, T.J. 1967. Ecological and behavioral aspects of predation by the Northern Shrike. *Living Bird* 6:43-86.
- CUSHING, J.E. JR. 1939. The relation of some observations upon predation to theories of protective coloration. *Condor* 41:100-111.
- DICE, L.R. 1947. Effectiveness of selection by owls of deer mice (*Peromyscus maniculatus*) which contrast in color with their background. *Contrib. Lab. Vert. Biol. Univ. Michigan, Ann Arbor.* 34:1-20.
- EMLIN, J.M. 1968. Optimal choice in animals. *Amer. Natur.* 102:385-389.
- ERRINGTON, P.L. 1967. Of predation and life. Ames, Iowa State Univ. Press.
- KAUFMAN, D.W. 1974a. Adaptive coloration in *Peromyscus polionotus*: experimental selection by owls. *J. Mammal.* 55:271-283.
- _____. 1974b. Differential predation on active and inactive prey by owls. *Auk* 91:172-173.
- KOPLIN, J.R. 1973. Differential habitat use by sexes of American Kestrels wintering in northern California. *Raptor Res.* 7(2):39-42.
- LORENZ, K.Z. 1966. On aggression. Chicago, Univ. Chicago Press.
- MARTI, C.D. AND J.G. HOGUE. 1979. Selection of prey by size in Screech Owls. *Auk* 96:319-327.
- MUELLER, H.C. 1971. Oddity and specific search image more important than conspicuousness in prey selection. *Nature* 233:345-346.
- _____. 1973. The relationship of hunger to predatory behavior in hawks (*Falco sparverius* and *Buteo platypterus*). *Anim. Behav.* 21:513-520.
- _____. 1974. Factors influencing prey selection in the American Kestrel. *Auk* 91:705-721.
- _____, AND D.D. BERGER. 1959. The bal-chatri; a trap for the birds of prey. *Bird Banding* 30:18-26.
- _____. 1970. Prey preferences in the Sharp-shinned Hawk: the roles of sex, experience and motivation. *Auk* 87:542-547.
- OGDEN, J.C., ET. AL. 1976. Prey selectivity by the Wood Stork. *Condor* 78:324-330.
- SLACK, R.S. 1975. Effects of prey size on Loggerhead Shrike predation. *Auk* 92:812-814.
- SNYDER, N.F.R. AND J.W. WILEY. 1976. Sexual size dimorphism in hawks and owls of North America. *Ornith. Monog.* 20:1-95.
- STORER, R.W. 1966. Sexual size dimorphism and food habits in three North American accipiters. *Auk* 83:423-436.
- TINBERGEN, L. 1960. The natural control of insects in pinewoods. 1. Factors influencing the intensity of predation by songbirds. *Arch. Neerl. Zool.* 13:265-343.

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First Received 24 December 1983; Accepted 1 December 1984

HABITAT SELECTION BY THE AMERICAN KESTREL (*Falco sparverius*) AND RED-TAILED HAWK (*Buteo jamaicensis*) WINTERING IN MADISON COUNTY, KENTUCKY

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ABSTRACT - Habitat selection by the American Kestrel (*Falco sparverius*) and Red-tailed Hawk (*Buteo jamaicensis*) in Madison County, Kentucky, was determined for the winter of 1980-81. Results showed that there was significant non-random use of 6 habitat types (Kestrels: $\chi^2 = 629.5$, $P < 0.05$, d.f. = 5; Red-tailed Hawks: $\chi^2 = 124.8$, $P < 0.05$, d.f. = 5) with old field sites being used most frequently by both species.

The American Kestrel (*Falco sparverius*) and Red-tailed Hawk (*Buteo jamaicensis*) are the most numerous diurnal raptors wintering in Madison County (Sferra 1984). Mengel (1965) reported that, in Kentucky, kestrels preferred open areas. Along highways in West Virginia, kestrels most often hunted in pasturelands, or open areas planted with *Lespedeza* spp. (Ferris 1974). However, near highways in the Texas panhandle, kestrels frequented wooded areas (Allan and Sime 1943).

Red-tailed Hawks were most commonly associated with woodlots in Iowa and the Texas panhandle (Allan and Sime 1943; Weller 1964). Petersen (1979) reported that Red-tailed Hawks seldom used internal portions of woodlots, supporting Schnell's (1968) observation that the species preferred perching at woodlot edges. In Michigan, open areas were heavily utilized (Craighead and Craighead 1956), lone trees being favored as perch sites (Chamberlain 1974).

High winter densities of these raptors in Madison County (Sferra 1984) may result from the amount of open habitat available for hunting, as well as the presence of adjacent, heterogeneous edge habitat. Many open areas are bordered by fencerows of trees or are bisected by power lines, providing perching sites from which hawks can search for prey. The purpose of the present study was to determine the relative extent to which wintering kestrels and Red-tailed Hawks frequented various habitats found in Madison County.

STUDY AREA AND METHODS

Madison County encompasses parts of 4 physiographic regions in central Kentucky: the Hills of the Bluegrass, the Outer Bluegrass, the Knobs Section of the Cumberland Plateau, and the Mountains (Soil Conservation Service 1973). Terrain ranges from rolling, upland plains to long, narrow ridge tops separated by steep valleys with the maximum relief being 335 m (Jillson 1928). Madison County is composed predominantly of pastureland and hayfields with forest stands being confined mainly to stream margins, field edges, and rugged regions of the Cumberland Plateau and Mountains.

Birds were located by means of an automobile road count (Craighead and Craighead 1956) covering secondary roads of the county. The count routes were chosen so that each of the physiographic regions in the county were represented. One road count was run weekly from late December 1980 to March 1981 for a total of 10 counts. Each covered the same 235 km and were not run when visibility was hampered by snow, fog, or rain. A driver/observer and passenger/observer were present during each census. Routes were driven at speeds between 32-48 kph, and all raptor sightings on both sides of the road were recorded. The maximum distance of sightings on each side of the road was approximately 440 m.

Habitats directly beneath raptors in flight, and areas overlooked by perched birds formed the basis for determining species-specific habitat utilization. Six habitat categories were distinguished: pastureland (both grazed pasture and mowed hayfields), cropland, urban areas, old fields, woodlots and plowed fields. Actual habitat use was tested against their relative occurrence. Proportion of occurrence was quantified from randomly selected aerial photographs representing 10% of the entire county.

RESULTS AND DISCUSSION

The six habitat types occurred in the following proportions: 57% pastureland and hayfields, 33% woodlots, 3% cropland, 3% urban areas, 2% old fields and 2% plowed fields. Kestrels and Red-tailed Hawks utilized certain habitats to a greater extent than that predicted by their relative availability. Chi-square (χ^2) tests showed significant non-random habitat use by kestrels and Red-tailed Hawks wintering in Madison County (Table 1).

Table 1. Results of Chi-square (χ^2) analysis of habitat selection and utilization based on habitat availability in Madison county.

SPECIES	χ^2
American Kestrel	629.5 ^a
Red-tailed Hawk	124.8 ^a

^a $P < 0.05$; d.f. = 5

Table 2. Total number of American Kestrel and Red-tailed Hawk sightings and % deviation from expected Chi-square values for their occurrence in each of 6 habitat types. A positive sign indicates habitat use greater than expected and a negative sign indicates use less than expected.

HABITAT	AMERICAN KESTRELS		RED-TAILED HAWK	
	N	% DEVIATION	N	% DEVIATION
Pastureland	276	+ 38	117	+ 28
Old Field	66	+790	21	+525
Cropland	15	+ 76	1	- 59
Plowed Fields	5	- 31	1	- 70
Woodlots	3	- 98	28	- 65
Urban Areas	0	-100	0	-100

Kestrels habitat use was as follows: pastureland 76.9%, old field 18.4%, cropland (consisting mainly of corn stubble) 4.2%, plowed field 1.4%, woodlots 0.8% and urban areas 0%. Percent deviations from expected values of the chi-square test showed that kestrels utilized woodlots and urban areas less, and all other habitats more than expected. Selection of old fields was most pronounced (Table 2).

The nature and distribution of perching sites in a given surveyed area probably introduced bias into road count data. In the Texas panhandle, for instance, frequent utilization of woodlots by kestrels (Allan and Sime 1943) could have been directly related to lack of perching sites in open habitat. In Madison County, the majority of kestrels were seen perching on utility lines, many of which run parallel to the census route. On the other hand, birds hidden behind trees, buildings and signs may have resulted in low utilization estimates for woodlot and urban area use.

Winter habitat separation by sexes has been reported as common among kestrels in Texas, California, Arizona, Mexico (Mills 1976; Koplin 1973) and Georgia (Stinson et al. 1981). Chi-square test showed male kestrels were significantly more numerous than females (58% males, $P < 0.05$). However, sex-specific differences in habitat were not significant in Madison County ($P < 0.05$).

Habitat selection by Red-tailed Hawks was as follows: pastureland 69.9%, woodlots 16.7%, old field 12.5%, cropland 0.6%, plowed fields and urban areas 0%. Use of pastureland and old field sites was greater than expected; all other habitats

were frequented less than expected (Table 2). The majority of Red-tailed Hawks associated with woodlots were perched along margins overlooking open areas. Similarly, Petersen (1979), using a road count in Wisconsin, found that internal portions of woodlots were seldom used.

Of all habitat types, old field site use by hawks deviated the most from the expected values. Selection for old field sites by kestrels, and to a lesser degree by Red-tailed Hawks, may have been induced by higher prey populations, specifically Meadow Vole (*Microtus pennsylvanicus*). Austing (1964) found Meadow Voles to be staple prey for Red-tailed Hawks during winter months, and vole population density has been suggested as the major factor determining hawk distribution (Bart 1977). Kestrels also depend heavily upon Meadow Voles during winter (Craighead and Craighead 1956). In Madison County, matted vegetation used by voles for runways will not accumulate on intensively grazed pastureland and mowed hayfields, resulting in decreased population density. Old field sites, based on presumed prey density, have the greatest potential for supporting large numbers of wintering kestrels and Red-tailed Hawks.

Acknowledgments

Special thanks are extended to those who helped in obtaining field data: R. Altman, G. Barels, P. Mastrangelo, G. Murphy, J. Schafer, C. Schuler, T. Towles, and especially J. Colburn.

LITERATURE CITED

ALLAN, D.F. AND P.R. SIME. 1943. A hawk census on Texas panhandle highways. *Wilson Bull.* 55:29-39.

- AUSTING, G.F. 1964. The world of the Red-tailed Hawk. J.B. Lippincott Co., Philadelphia. 128 pp.
- BART, J. 1977. Winter distribution of Red-tailed Hawks in New York State. *Wilson Bull.* 89:623-625.
- CHAMBERLAIN, M.L. 1974. Fall hunting behavior of the Red-tailed Hawk (*Buteo jamaicensis*) in Central Michigan. *Jack-pine Warbler* 52:2-9.
- CRAIGHEAD, J.J. AND F.C. CRAIGHEAD, JR. 1956. Hawks, owls and wildlife. Stackpole, Harrisburg, Pa. 443 pp.
- FERRIS, C.R. 1974. Effects of highways on Red-tailed Hawks and Sparrow Hawks. M.S. Thesis. West Va. Univ., Morgantown, W. Va.
- JILLSON, W.R. 1928. The geology and mineral resources of Kentucky. Ky. Geol. Survey, Frankfort, Ky.
- KOPLIN, J.R. 1973. Differential habitat use by sexes of American Kestrels wintering in Northern California. *Raptor Res.* 7:39-42.
- MENGEL, R.M. 1965. The birds of Kentucky. *Ornithol. Mono. No. 3*, Am. Ornithol. Union, Lawrence, Kansas.
- MILLS, G.S. 1976. American Kestrel sex ratios and habitat separation. *Auk* 93:740-748.
- PETERSEN, L. 1979. Ecology of the Great Horned Owl and Red-tailed Hawk in southeastern Wisconsin. *Wisc. Dept. Nat. Res. Tech. Bull. No. 111*, Madison, Wisc. 63 pp.
- SCHNELL, G.D. 1968. Differential habitat utilization by wintering Rough-legged and Red-tailed Hawks. *Condor* 70:373-377.
- SFERRA, N.J. 1984. Population densities of diurnal raptors wintering in Madison County, Kentucky. *Trans. Ky. Acad. Sci.* 45 (3-4):128-131.
- SOIL CONSERVATION SERVICE. 1973. Soil survey of Madison County, Kentucky. U.S.D.A. and Ky. Agri. Exp. Sta., Lexington, Ky.
- STINSON, C.H., D.L. CRAWFORD AND J. LAUTHNER. 1981. Sex differences in winter habitat of American Kestrels in Georgia. *J. Field Ornith.* 52:29-35.
- WELLER, M.W. 1964. Habitat utilization of two species of Buteos wintering in central Iowa. *Iowa Bird Life* 34:58-62.
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Received 15 July 1984; Accepted 30 January 1985

SHORT COMMUNICATIONS

A Clutch Of Unusually Small Peregrine Falcon Eggs

M. ALAN JENKINS

Unusually small (dwarf or runt) eggs are rare, occurring at a frequency of 0.05-0.09% in the Domestic Chicken (*Gallus gallus*) (Romanoff and Romanoff 1949), 0.08% in the Common Grackle (*Quiscalus quiscula*), and 0.18% in the Red-winged Blackbird (*Agelaius phoeniceus*) (Rothstein 1973). More than one small egg in a clutch is even rarer. Pearl and Curtis (1916 cited in Romanoff and Romanoff 1949) found only 11% of chickens that laid any small eggs laid more than one, i.e. about 0.0055-0.0099% over all.

Small Peregrine Falcon (*Falco peregrinus*) eggs, here defined as those less than 40 ml in estimated volume, are also rare (Table 1). Although accurate frequency data from the wild are not readily available, Burnham (pers. comm.) found only 1 small egg in about 350 (0.3%) he has handled. Most small eggs occur as runts, an odd egg in an otherwise normal clutch (Ratcliffe 1980). The 2 eggs of the clutch described here are smaller than any noted in the literature for North American peregrines. That both eggs were small suggests a "normal" egg size for this female rather than odd eggs. I found the clutch in a Sonoran eyrie on 8 May 1981. This site was first known to be occupied in 1978 when an adult was seen there in mid-March. A pair of adults vigorously defended this area in late April of 1980, but the exact eyrie location was not found. The eyrie site used in 1981 was a small cave (ca. 2 X 2 X 2 m in size and hemi-conical in shape) near the top of an igneous cliff. There were 2 eggs in a scrape near the back wall of the cave. The eggs were cool to the touch and their contents sloshed when gently shaken, indicating they were addled. On 8 May successful eyries in this area should have contained nestlings, as had 10 other eyries previously visited. The estimated mean hatching date for Gulf of California peregrines is 12 April (n=31), the latest known hatching date is 15 May (Porter et al. in prep.).

I measured the 2 eggs with a caliper having a Vernier scale marked in increments of 0.1 mm; the results are given in Table 1 as eggs A and B. Table 1 also compares the size of these 2 eggs with some published dimensions of small and average-sized Peregrine Falcon eggs.

Several factors have been given as causes for abnormally small bird eggs. Chickens may occasionally lay yolkless eggs which weigh only a few grams (Romanoff and Romanoff 1949). The only known yolkless peregrine egg from the wild, also from the Gulf of California, was noted by Risebrough (1971). This egg was small but its dimensions were not given. In captivity, yolkless eggs occur about once in 300 eggs; one measured 33.2 X 25.0 mm

(Burnham pers. comm.). The sizes of eggs laid by individual peregrines may also vary with age; small eggs are produced by young females laying for the first time (Blair 1967) but also by old females (Ratcliffe 1980). The eggs of one female reported by Ratcliffe (1980) from Britain decreased in size in an 8-y period from almost normal eggs averaging 50.0 X 39.5 mm (39.7 ml) to the smallest recorded size of 4 eggs averaging 46.5 X 32.5 mm (25.0 ml).

Racial differences in egg size occur but are not great (Brown and Amadon 1968). The small-bodied subspecies *babylonicus* (considered by some to be a separate species) has the smallest mean egg size according to Brown and Amadon (1968) and is similar in body and egg size to the small *F. p. minor* (Table 1). Egg size variation due to racial differences are probably related to female body weight differences. Romanoff and Romanoff (1949) state that the smallest chicken eggs are produced by the lightest females.

The first egg of a cycle (clutch) in the chicken is generally the heaviest, decreasing thereafter (Romanoff and Romanoff 1949). Physical condition, nutrition, and climatic conditions can also affect egg size (Romanoff and Romanoff 1949).

Olsen (1982) found that peregrine egg size increased with increasing latitude (in the southern hemisphere), use of tree hollows as nests, and decreasing temperatures. These relationships disappeared in certain areas after the 1940s, a period corresponding with the introduction of DDT and intensification of land use. Olsen (1982) found no significant difference in egg size between the first and replacement clutches from the same nest site, nor any correlation between clutch size and egg size.

Some of the above causes of small eggs can be eliminated as factors in the Gulf of California clutch. The female defending the nest was seen clearly at close range and was in full adult plumage with no immature feathers remaining. She probably was at least in her third calendar year of life and had probably laid other clutches. However, it is possible that she was a very old female. Racial differences in egg size can be eliminated because the eggs of this clutch are far smaller (ca. 35% less in estimated volume) than average eggs of the small subspecies *F. p. babylonicus*. The order of laying was not a factor because both eggs were unusually small. Whether or not the eggs were yolkless is not known, but it is unlikely that 2 such eggs would occur together. The effects of low latitude and warm temperatures as found by Olsen (1982), could be

Table 1. Dimensions of Peregrine Falcon eggs. Maximum length (L) and breadth (B) are in mm; estimated volume (V) was calculated according to Hoyt (1979) and is in ml.

LOCALITY	SMALL EGGS ^A OR MINIMUM MEASUREMENTS ^B			AVERAGE-SIZED EGGS				REFERENCE
	N	L	B	V	N	L	B	V
<i>F.p. anatum</i> :								
Sonora (A)	1	44.2	34.3	26.5				This paper.
Sonora (B)	1	44.4	34.8	27.4				This paper.
Gulf of California					2	52.0	41.8	46.2
Baja California	2 ^c	49.4	39.2	38.6	17 ^c	53.2	41.3	46.2
North America	124 ^b	46.5	37.6	33.5	124	52.8	41.1	45.4
North America	1	48.5	38.5	36.6	61	52.0	41.0	44.5
<i>F.p. peregrinus</i> :								
Britain	3	48.6	37.2	34.2				Blair 1967.
Britain	1	46.0	38.2	34.2	100	51.8	41.0	44.3
Britain	4	46.5	32.5	25.0	2,253	51.5	40.8	43.6
Britain	1	32.2	27.3	12.2				Ratcliffe 1980.
Germany, Poland	165 ^b	46.2	39.1	36.0	165	51.5	40.5	43.0
<i>F.p. calidus</i> :								
Eurasian tundra	202 ^b	46.0	37.0	32.1	202	53.0	42.0	47.6
<i>F.p. babylonicus</i> :								
Asian steppes, deserts						50.5	40.2	41.5
<i>F.p. minor</i> :								
Africa south of Sahara		47.9	38.0	35.2		50.6	40.2	41.6

^aSmall eggs are those less than 40 ml in estimated volume.^bSome authors reported ranges of egg measurements. In these instances I used the smallest dimensions given even though the length and breadth may not have been from the same egg; here n = the total sample size.^cMeasurements are of one egg each from 19 clutches.

important because the eyrie is near the southern limit of peregrine distribution for the northern hemisphere, and is in an area that has mild temperatures during the time peregrines nest. Nevertheless, it is unlikely that even both of these effects in combination could produce such a large reduction from the average.

Thanks are due to M.A. Bogan, W.A. Burnham, L.F. Kiff, R.L. Phillips, R.D. Porter, and D.Q. Thompson for review and suggestions on an earlier draft of the manuscript. S. Sumida measured eggs from Baja California, Mexico, in the Western Foundation of Vertebrate Zoology collection. The 1981 field work would not have been possible without the cooperation and help of R. A. Graham, R.S. Ogilvie, J.R. Swift, and Alfonso de Anda T. of the Direccion General de Fauna Silvestre of Mexico.

ADDENDUM

An additional record of a small peregrine egg was recently brought to my attention. Charles Bendire (Smith. Inst. Spec. Bull. No. 1, 1892) noted an egg with dimensions of 38.5 mm x 30 mm (L x B). This egg is smaller than any I could find recorded, but it was a single example (a runt) and not a clutch as in the case of the Sonoran eggs.

LITERATURE CITED

- BANNERMAN, D.A. AND G.E. LODGE. 1956. The birds of the British Isles, Vol. 5, Oliver & Boyd, Ltd., Edinburgh and London.
- BENT, A.C. 1938. Life histories of North American birds of prey. Part 2. U.S. Nat. Mus. Bull. 170.
- BLAIR, H.M.S. 1967. On two exceptional clutches of peregrines' eggs. *Oologists' Record* 41:6-7.
- BROWN, L. AND D. AMADON. 1968. Eagles, hawks and falcons of the world. McGraw-Hill Book Co., New York.
- CRAMP, S. (ED.). 1980. Handbook of the birds of Europe, the Middle East, and North Africa, Vol. 2 Oxford Univ. Press, Oxford.
- GLUTZ VON BLOTZHEIM, U.N., K.M. BAUER, AND E. BEZZEL (EDS.). 1971. Handbuch der Vogel Mitteleuropas, Vol. 4. Akademische Verlagsgesellschaft, Frankfurt am Main.
- HOYT, D.F. 1979. Practical methods of estimating volume and fresh weight of bird eggs. *Auk* 96:73-77.
- OLSEN, P.D. 1982. Ecogeographic and temporal variation in the eggs and nests of the peregrine, *Falco peregrinus*. (Aves: Falconidae) in Australia. *Aust. Wildl. Res.* 9:277-291.
- RATCLIFFE, D. 1980. The Peregrine Falcon, Buteo Books Co., Vermillion, S.D.
- RISEBROUGH, R. 1971. Baja California. Pp. 126-127 in Research planning conference on peregrines and other birds of prey, Cornell University, Ithaca, New York, November 7-9, 1969-part 2, K. Hodson, (ed.). *Raptor Res. News* 5:123-131.
- ROMANOFF, A.L. AND A.J. ROMANOFF. 1949. The avian egg. John Wiley and Sons, Inc., New York.
- ROTHSTEIN, S.I. 1973. The occurrence of unusually small eggs in three species of songbirds. *Wilson Bull.* 85:340-342.
- USFWS, Denver Wildlife Res. Ctr., Bldg. 16, Fed. Ctr., Denver, CO 80225. Present Address: George Miksch, Sutton Avian Res. Ctr., Inc., P.O. Box 2007, Bartlesville, OK 74005-2007.

Received 20 February 1983; Accepted 28 April 1984

Eyrie Aspect as a Compensator for Ambient Temperature Fluctuations: A Preliminary Investigation

RICHARD N. WILLIAMS

Raptor ecologists have long recognized that nest site characteristics may influence reproductive success for many birds of prey (Olendorff 1973; Porter and White 1973; Ogden and Hornocker 1977). However, few studies have demonstrated relationships between nest site characteristics and physical factors that may provide energetic or reproductive advantages.

It has been suggested that the Prairie Falcon (*Falco mexicanus*) prefers nest sites with a southerly exposure (Enderson 1964; Olendorff 1973; Porter and White 1973; Denton 1975; Ogden and Hornocker 1977). Additionally,

Leady (1972) and Williams (1981) noted a component of easterly-facing eyries. McGahan (1968) speculated that an easterly eyrie aspect in Golden Eagle (*Aquila chrysaetos*) in Montana may negate early morning chill and temper afternoon heat, however, he did not test this prediction.

In 1980, I studied the reproductive phenology of a local population of Prairie Falcons nesting at high elevations ($\bar{x} = 2720 \pm 199$ m) in central Colorado (Williams 1981). Of the 14 eyries examined, 7 had east or southeasterly aspects between 93-165°. I initiated a preliminary investigation using one of these eyries to estimate the relationship bet-

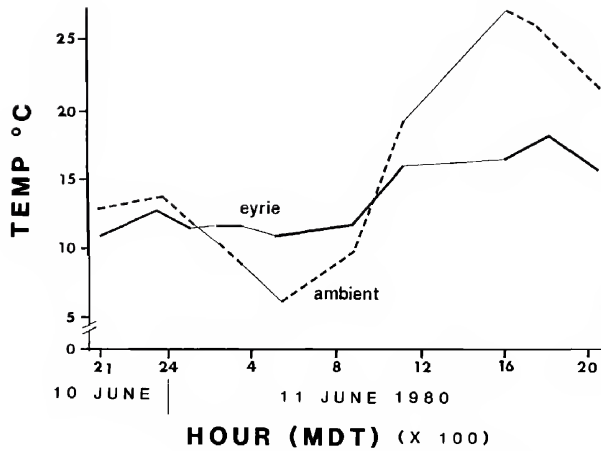


Figure 1. Eyrie and ambient temperatures for eyrie No. 2, 10-11 June 1980. Solid line denotes eyrie temp. Dashed line denotes ambient temp. Thin lines represent time periods when data were not collected.

between eyrie aspect, eyrie temperature and ambient temperature.

I collected eyrie and ambient temperatures over a 23 h period (2100 H MDT 10 June 1980 - 2000 H MDT 11 June 1980) from eyrie No. 2 (Williams 1981) in North Park, Colorado (eyrie aspect = 95°, cliff aspect = 80°, elevation = 2650 m). Temperatures were recorded using a Yellow Springs Thermistor Unit with wire temperature probes. Eyrie temp was monitored via a wire probe taped to the rear wall of the eyrie. The probe was in the shade at all times, placed 0.4 m above and behind the nestlings in the center rear portion of the eyrie. I do not believe the probe was close enough to the nestlings to have been influenced by their metabolic heat. The nestlings were 16 d old at this time. Ambient temperatures were collected in the shade at the cliff base. Temp was recorded at 15 min intervals from a secluded spot 30 m from the eyrie where my presence seemed to have no effect on the behavior of the adult birds. Weather during the 23 h period was clear with winds between 12-18 kph.

Minimum and maximum eyrie and ambient temp and ranges during the study period are shown in Figure 1. Eyrie temp was higher than ambient temp from 0100-0930 H, whereas ambient temp was higher than eyrie temp from 2115-0100 H and 0930-2000 H. Paired t-Tests were used to compare ambient temps higher and lower than eyrie temps. Both tests were significant: higher ($t = 7.07$, $df 31$, $P < 0.01$) and lower ($t = 10.9$, $df 17$, $P < 0.01$).

Ambient temp fluctuated 21.2° C, whereas eyrie temp fluctuated only 7.4° C during the 23 h sampling period (Fig. 1), suggesting that a microclimate exists within easterly-facing eyries which buffers nestlings from ambient temp extremes. This buffering is most readily seen where early morning and late afternoon ambient temps

varied greatly from eyrie temp. Eyrie and ambient temps were equal (13° C) at 1000 H. Eyrie temp increased only 4° C during the next 8 hours, whereas, ambient temp increased 14° C. Platt (1974) noticed a 5-8° C difference between ambient and eyrie temperatures, with the eyrie invariably cooler during the hottest time period of the day. Clayton M. White (pers. comm.) also noted clear differences between ambient and cliffside temperatures while entering Gyrfalcon (*Falco rusticolis*) and Peregrine Falcon (*Falco peregrinus*) eyries in Alaska.

In the cold climates of both Alaska and high elevation Colorado, environmental temperature fluctuations are apparently ameliorated by the action of solar radiation falling on the cliff surface. The cliff functions as a heat sink during the day, slowly absorbing heat from solar radiation and serves as a heat source at night, slowly losing the absorbed heat to the cooler night air. This keeps the cliff-face warmer than the minimum ambient temp at night and cooler than the maximum ambient temp during the day. Nesting falcons were able to utilize the moderated environment to initiate reproductive activities (courtship and egg-laying) while ambient conditions were still quite harsh. In both Alaska (C.M. White pers. comm.) and Colorado (Williams 1981), this was necessary so that nestling phenology was timed with peak abundances of prey species.

The relatively moderate microclimate of eyries should enhance nesting success. Adult falcons can devote less time to brooding and shading of young during daylight hours, thereby providing increased time for predator detection, eyrie defense and hunting. Increased prey deliveries would greatly benefit the youngest nestlings, who often do not survive the nestling period during times of food shortage. All of these factors could increase the

probability of nesting success and the number of young fledged by reducing nestling mortality.

Further studies are needed to define the role of eyrie aspect in nest site selection by Prairie Falcons. Data on eyrie and ambient temperatures from the courtship to fledging phases of nesting phenology should be collected from north, south, west, and east facing eyries across a spectrum of elevational and latitudinal locations. Such information could be coupled with existing data on nest site selection and productivity to identify general trends (and local patterns) in nest site selection of Prairie Falcons throughout their breeding range.

ACKNOWLEDGMENTS

I would like to thank C.M. White and J.R. Parrish for their input and encouragement during the preparation of this manuscript. Financial assistance was provided by the Frank M. Chapman Memorial Fund and the Colorado Division of Wildlife through Federal Aid in Wildlife Restoration Project W-124-R.

LITERATURE CITED

- DENTON, S.J. 1975. Status of prairie falcons breeding in Oregon. M.S. thesis. University of Oregon, Eugene, Oregon.
- ENDERSON, J.H. 1964. A study of the prairie falcon in the central Rocky Mountain region. *Auk* 81:332-352.
- LEEDY, R.R. 1972. The status of the prairie falcon in western Montana: emphasis on possible effects of chlorinated hydrocarbon pesticides. M.S. thesis. University of Montana, Missoula, Montana.
- MCGAHAN, J.E. 1968. Ecology of the golden eagle. *Auk* 85:1-12.
- OGDEN, V.T. AND M.G. HORNOCKER. 1977. Nesting density and success of prairie falcons in southwestern Idaho. *J. Wildl. Mgt.* 41:1-11.
- OLENDORFF, R.R. 1973. Ecology of the nesting birds of prey of northeastern Colorado. U.S. I.B.P. Grasslands Biome Technical Report 211.
- PLATT, S.W. 1974. Breeding status and distribution of the prairie falcon in northern New Mexico. M.S. thesis. Oklahoma State University, Stillwater, Oklahoma.
- PORTER, R.D. AND C.M. WHITE. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. *Brigham Young University Science Bulletin* 28:1-74.
- WILLIAMS, R.N. 1981. Breeding ecology of prairie falcons at high elevations in central Colorado. M.S. thesis. Brigham Young University, Provo, Utah.
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Received 1 November 1984; Accepted 15 December 1984

Successful Breeding of a Pair of Sharp-shinned Hawks in Immature Plumage

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Adult plumage in *Accipiter* is usually acquired during an individual's second summer (1 year after hatching). Since this molt is not completed until the following fall, nesting accipiters can be easily identified as immature (yearling) or adult (2 or more years) on the basis of plumage. Although Bent (1937) stated that each of the three North American *Accipiter* species may breed as yearlings, published accounts of such breeding, particularly of yearling males, are uncommon. In the Northern Goshawk (*A. gentilis atricapillus*) and the Cooper's Hawk (*A. cooperii*), yearling females are known to occasionally pair with adult males and breed (Meng 1951; McGowan 1975; Reynolds and Wight 1978). I could find no published account of such pairing in the Sharp-shinned Hawk (*A. striatus*). However, K. Tuttle (pers. comm.) observed this at 1 of 26 nests found in Utah and Idaho during the 19-y period 1963-1981, and C.M. White (pers. comm.) saw this at another Utah nest in 1963. Breeding by yearling males is apparently a rare event. Two cases each of breeding by yearling male Cooper's Hawk (Kline 1975; Rosenfield and Wilde 1982) and European Goshawk (*A. gentilis*) (Glutz

von Blotzheim 1971) have been reported. R. Rosenfield (pers. comm.) has recently observed this at 2 additional Cooper's Hawk nests. To my knowledge, breeding by yearling male Sharp-shinned Hawks has not been documented. K. Tuttle (pers. comm.) observed this in 1973 at a Utah nest site at which an adult male had been shot and killed the previous year. This note documents the successful breeding of a pair of Sharp-shinned Hawks, both in immature plumage.

On 23 May 1983, while searching for nests as part of a breeding ecology study of accipiters in central Utah, I encountered an immature female Sharp-shinned Hawk in what later proved to be the nest stand. The male was first observed on 3 June and appeared virtually identical to the female in plumage and eye color. It was easily separable by its smaller size and higher pitched call.

The nest stand was at an elevation of @ 2000 m on a gentle, north-facing slope in the Uinta National Forest, 8 km northeast of Provo, Utah County. A partially constructed nest was found during the initial observation of the female. The nest was located 4 m above ground near

the trunk of a small white fir (*Abies concolor*) within a stand dominated by bigtooth maple (*Acer grandidentatum*) and Gambel oak (*Quercus gambelii*). No old nests were found in the stand. On 7 June the nest contained 3 eggs. All eggs hatched, but 1 chick disappeared the first wk after hatching. The 2 remaining young fledged by 15 August and were last seen in the nest stand on 23 August.

During incubation the female could be approached to within 3 m and could have been hand-netted on numerous occasions. With the exception of this extreme tolerance of the female to close approach, the behavior of the pair was similar to neighboring pairs. The immature female noted by White in 1963 could be touched while on the nest incubating.

Newton et al. (1981) reported that in a relatively stable population of the European Sparrowhawk (*A. nisus*), yearlings formed 17% of the breeding males and 16% of the breeding females. In *A. striatus* and *A. cooperii*, yearlings (especially males) appear to comprise a much smaller proportion of the breeding population than in *A. nisus*, though the reasons for this are not clear. Meng (1951), Hennessy (1978) and Reynolds and Wight (1978) reported that yearlings formed 6% (N=36), 20% (N = 15) and 6% (N = 34), respectively, of breeding females of Cooper's Hawk populations in New York, Utah and Oregon. Though males were not observed at every nest, all seen by these authors were adult. On the basis of examination of testes of 10 immature male Goshawks, Høglund (1964) concluded that immature males are normally incapable of breeding. This may also be true of yearling males in *A. cooperii* and *A. striatus*, but to my knowledge, has not been studied. Reynolds (1972) discussed the general lack of nesting by yearling male Goshawks, Coopers Hawks and Sharp-shinned Hawks and hypothesized that since males are the principal food providers during the nesting season, foraging experience may be a prerequisite for successful nesting. Reynolds and Wight (1978) suggested that an immature male, lacking experience, may be subject to greater risk of predation or accident while foraging, and therefore, deferring the age of first breeding may increase its future fitness. A concomitant of deferred breeding is delayed sexual maturity. However, a similar argument should apply to the ecologically similar *A. nisus*, yet considerable numbers of European Sparrowhawks, and at least as many males as females, breed successfully their first year (Newton et al. 1981). Furthermore, the relatively larger proportion of yearling breeders is found in both stable and recovering populations, though it may be accentuated in the latter (Newton, pers. comm.). The breeding biology of the closely related Sharp-shinned Hawk has not been intensely studied, and breeding by yearlings, including males, may not be as rare as might be concluded from existing observations.

I thank R.L. Yergensen and K. Ellis for assistance in the field and Robert Redford and Brigham Young University for financial support. K. Tuttle, R. Rosenfield and I.

Newton graciously provided unpublished data. J.R. Murphy, C.M. White, R.T. Reynolds, R. Fitzner and D.H. Ellis reviewed the manuscript.

LITERATURE CITED

- BENT, A.C. 1937. Life histories of North American birds of prey, Part 1. *U.S. Nat. Mus. Bull.* 167.
- GLUTZ VON BLOTZHEIM, N. 1971. Handbuch der Vogel Mitteleuropas. Vol. 4. Falconiformes. Akademische Verlagsgesellschaft, Frankfurt am Main.
- HENNESSY, S.P. 1978. Ecological relationships of Accipiters in Northern Utah — with special emphasis on the effects of human disturbance. M.S. thesis. Utah State University, Logan.
- HØGLUND, N. 1964. Der habicht *Accipiter gentilis* Linne in Fennoskandia. *Viltrevy* 2:195-270.
- KLINE, R. 1976. An eagle and a hawk. *J. Calif. Hawking Club* 1975:16-17.
- MCGOWAN, J.D. 1975. Distribution, density and productivity of Goshawks in interior Alaska. Alaska Dept. of Fish and Game. P-R Proj. Rep., W-17-445.
- MENG, H.K. 1951. The Cooper's Hawk *Accipiter cooperii* (Bonaparte). Ph.D. Thesis, Cornell University, Ithaca, New York.
- NEWTON, I., M. MARQUISS AND D. MOSS. 1981. Age and breeding in Sparrowhawks. *J. An. Ecol.* 50:839-853.
- REYNOLDS, R.T. 1972. Sexual dimorphism in accipiter hawks: A new hypothesis. *Condor* 74:191-197.
- , AND H.M. WIGHT. 1978. Distribution, density and productivity of accipiter hawks breeding in Oregon. *Wilson Bull.* 90:182-196.
- ROSENFELD, R.N. AND J. WILDE. 1982. Male Cooper's Hawk breeds in juvenile plumage. *Wilson Bull.* 94:213.

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Received 28 September 1984; Accepted 1 October 1984

Aegyptius Monachus Carrying Food In Its Claws

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On 24 September 1983, while taking a census of the Black Vulture (*Aegyptius monachus*) on the island of Mallorca (Balearic Islands) for ICONA (Ministerio de Agricultura), we observed an adult of this species flying with a relatively large, whitish object in its claws. The bird approached our observatory (Alfabia, 1,067 m above sea level) following the area's mountain crests at a height of approximately 30 - 50 m above the terrain. We could not determine where it came from — possibly from far away. After observing its flight — straight — for about 5 min, we saw it land on a rocky promontory 500 m from our position. It began to peck at the object in its claws. With the aid of binoculars (8 & 9x) we confirmed the fact that the bird was eating. With almost complete certainty the vulture had transported a part of a sheep (*Ovis aries*) which constitutes its basic diet on the island (70% according to Mayol (*Soc. Hist. Nat. Bal.*, 22:150-178, 1976.))

Our observation is of ethological interest, since no author cites this bird's ability to carry food in its claws (Bernis *Ardeola*, 12:45-99, 1966), Valverde (*Ardeola*, 12:101-115, 1966), Cramp and Simpson (Handbook of the Birds of Europe, the Middle East and North Africa, Vol II, Hawks to Bustards, R.S.P.B., Oxford University Press, 1980)). We must nevertheless mention the observation of Hiraldo (*Donana acta vertebrata* 3(1):19-31, 1976) referring to a Black Vulture presumably capturing a lizard (*Lacerta* sp.). These observations confirm the fact that the Black Vulture,

the only species of Palearctic vulture known to us to have this behavior, maintains the grasping capacity of its claws to a greater extent than other species of the group.

Unidad de Vida Silvestre, ICONA, Pasaje Guillermo de Torrela no. 1, Palma de Mallorca, Baleares.

Received 20 August, 1984; Accepted 1 September 1984

THESIS ABSTRACTS

Ecology of Breeding Burrowing Owls in the Columbia Basin, Oregon

The ecology of breeding Burrowing Owl (*Athene cunicularia*) was studied in northcentral Oregon during the spring and summer of 1980 and 1981. Pairs began arriving on the study areas as early as the first week of March; however, most arrivals were during April. Egg-laying began the first week of April and continued into the first week of May. Whole family groups left the nesting areas as early as the first week in July while members of other families remained until at least the end of September.

Nest success was 57% for 63 nests in 1980 and 50% for 76 nests in 1981. Desertion was the major reason for nest failure and may have been related to the proximity of other nesting pairs. Badgers (*Taxidea taxus*) were the major nest predators. Nests which were lined with cow or horse dung were significantly less prone to predation than nests not lined, suggesting dung masks odors of nest occupants.

Diets were determined by pellet analysis. Arthropods comprised 91.6% of the total prey by number; however, they contributed only 22.0% of the total biomass. Vertebrates, mostly small mammals, comprised the balance. *Perognathus parvus* (Great Basin Pocket Mouse) was the most important vertebrate prey and *Stenopelmatus fuscus* (Jerusalem Cricket; Gryllacrididae) was the most important arthropod. Coleoptera were preyed upon very heavily, but they were dominated by very small (< 10 mg) beetles and, therefore, contributed little to the total biomass. Burrowing Owls preyed on mammals during the spring then shifted to insects during the summer. Burrowing Owl diets were influenced by soil type, and owls selected mammals in proportion to their occurrence in the environment.

Burrowing Owls selected 3 of 5 habitats for nesting. Hole availability and possibly food availability as important prerequisites function analysis indicated variables responding to horizontal visibility and possibly food availability as important prerequisites for nest selection. Soil texture greatly influenced re-use and longevity of nest burrows. — Green, Gregory A. 1983. M.S. thesis, Oregon State Univ., Corvallis.

Reproductive Ecology and Habitat Utilization of Richardson's Merlins in Southeastern Montana

Reproductive ecology, food habits, habitat utilization, and eggshell quality of Richardson's Merlin (*Falco columbarius richardsonii*) in southeastern Montana were examined. Breeding activity spanned five months. Clutch size, brood size, and fledging success at active nests were similar ($P > 0.05$) among four years. Birds comprised >90% of individual prey items, and 61% of avian prey species were typically associated with predominantly open habitats. Horned Lark (*Eremophila alpestris*), Lark Bunting (*Calamospiza melanocorys*), and Vesper Sparrow (*Poocetes gramineus*) collectively comprised 57% of all prey. Home ranges of three breeding male Merlins encompassed approximately 13, 23, and 28 km², and each male traveled a maximum of 8 to 9 km from his nest. These home ranges encompassed five physiognomic habitat types. Percentages of total observations by habitat type indicated greatest use of sagebrush and grassland habitats. Sagebrush, riparian, and ponderosa pine habitats were used more ($P < 0.05$) than expected, but grassland and agriculture habitats received less ($P < 0.05$) use than expected. Comparisons of Montana eggshells with pre-pesticide (pre-1946) eggshells indicated 12% and 20% reductions in eggshell weight and eggshell thickness indices, respectively. These reductions were significant ($P < .$). Seven organochlorine compounds were detected in eggs collected on the study area. The overall management goal should be maintenance of a viable Merlin population and the habitat features essential for its continued existence. Management recommendations include limitation of alteration of ponderosa pine sideslope habitat, restriction of activities from 10 March through 20 July, rescheduling of activities, establishment of 400 m zones of no disturbance surrounding nests, limiting loss of prairie habitat and sagebrush removal, limiting use of organochlorine compounds, reviewing potential impacts of activities prior to their occurrence, and maintaining confidentiality of nest locations. — Becker, Dale M. 1984. M.S. Thesis, University of Montana, Missoula.

THE RAPTOR RESEARCH FOUNDATION, INC., YEAR-END REPORT

This was another year of firsts! We broke the 700 member number for starters and, for the first time distributed a comprehensive Membership Directory (named "The Kettle", of course). Dick Clark and his crew did an especially good job on that directory and we thank them for their efforts above and beyond the call of duty. As usual, the annual meeting (in Blacksburg, Virginia, this year) was the highlight of the year's activities. Roughly 300 raptor enthusiasts attended a very well-organized and smoothly-run conference held at the Donaldson Brown Center for Continuing Education at the Virginia Polytechnic Institute and State University. Papers ranged from topics on Condors to Screech Owls and the workshops provided valuable hands-on technique experience, e.g. transmitter attachment to eagles, etc.

The banquet was well-attended and lots of fun, with full credit going to Jim Fraser and his fellow organizers. A special thanks goes to Jim's wife for the music and dancing of an Appalachian fiddle-plucking and boot-stomping ensemble. The Andersen Award for Best Student Paper, again, went to the east Canadians working out of McGill University. Reed Bowman won the honor this year for his presentation of his M.Sc. results entitled "Behavior of Widow and Replacement Mates in Wild American Kestrels." Congratulations also go to the runners-up, Andre Lavigne ("Growth of Nestling Kestrels in Relation to Dietary Facts") and Nicole Vanderheyden ("Investigations into the Hematology of Captive American Kestrels"). And no, their major Professor, David Bird, wasn't on the selection committee!

Next year's RRF conference to be held in Sacramento, California promises to be one of the biggest ever. But don't let the length of the conference scare you. The program has been arranged in such a way as to allow participants to pick and choose the various symposia and meetings of particular interest. Frankly, sunny California at that time of year, i.e. November 2 - 10, 1985, is enough to entice most folks for the duration. It promises to be a momentous occasion in raptor conservation history. For more information, write to: Dr. Richard R. Olendorff, U.S. Bureau of Land Management, 2800 Cottage Way, Sacramento, California 95825.

The Conference Guidelines Committee composed of Toni and Dave Bird, myself, Ed and Judy Henckel, Butch Olendorff, Nancy Venizelous and Jim Fraser has been very active in promoting excellence in RRF meeting organizational efforts. A manual and questionnaire on this subject are now in rough draft format and we are very interested in your comments. Please send them to Dr. Bird (at Macdonald Raptor Research Centre, Macdonald Campus of McGill University, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec H9X 1C0). I am pleased to announce that the 1986 RRF meeting will be in Gainesville, Florida, under the direction of Dr. Michael Collopy. We are now looking for bids for the 1987 conference from places located in either the mid-west or far west. Applicants will need: a central meeting place capable of housing roughly 500 participants; easy access to major transportation centers, and; a good pool of hard-working volunteers. Send your bid to Dr. Bird at the above address.

One of the topics of intense discussions, especially among Board members was the journal, both as to format and timing. Specific changes have been implemented, including the formation of a working committee of associate editors, which will help with the manuscript review process. I am confident that by early 1985, *Raptor Research* will be going out on time. Furthermore, I personally like the new professional format, thanks to the efforts of our volunteer editor, Dr. Clayton White and his part-time Assistant Editor, Jimmie Parrish.

I am more than pleased to tell you that RRF memberships have reached 770, our highest ever, with more and more international members joining us each year. It is not just the journal publication you support with your annual dues, but also a strong voice in raptor conservation, encouragement of young scientists to pursue excellence in raptor research and management, and the establishment of research grants and awards for dedication to raptor conservation. Most important, your involvement supports a solid network of diverse individuals and organizations with identical objectives in mind and heart. Let's shoot for a thousand members for the end of 1985. Join (or rejoin) our swelling ranks!

As an update on Directors and Officers, the Board decided to keep me around for another year, as your President. Sadly, we could not cajole our hard-working, devoted Secretary for the past two years, Ed Henckel, to renew his post, but happily for RRF, Jim Fraser has consented to take on this tedious task. The results of your ballots are in: Jim Mosher and Martin Bötcher remain in their positions of Eastern and International Directors, respectively, and Rich Howard won his bid for the At-Large #3 Director's slot. Congratulations to all and a hearty thanks to our outgoing At-Large Director, Mark Fuller, for a job well-done and his encouragement for "new blood" in the organization.

Warmest wishes for success in the new year. See you in Sacramento next fall!

Jeff Lincer
PRESIDENT

MEMBERSHIP RECOGNITION

The Raptor Research Foundation, Inc., expresses sincere appreciation to the following individuals for their continued support of the Foundation and its objectives.

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THE RAPTOR RESEARCH FOUNDATION CONFERENCE — NOVEMBER 1985. The 1985 Raptor Research Foundation International Meeting and Symposium on the Management of Birds of Prey will be held at the capital Plaza Holiday Inn in Sacramento, California, November 2 - 10, 1985. Highlights of this 20th anniversary meeting of the Foundation will include 1) the Second RRF Conference on Raptor Conservation Techniques — Twelve Years of Progress, 1973-1985, 2) a Western Hemisphere Meeting of the World Working Group on Birds of Prey (ICBP), 3) the Second International Vulture Symposium, 4) a Western North America Osprey Symposium, 5) a Workshop on North American Candidate Endangered Raptors, 6) an International Symposium on Raptor Reintroduction, and 7) a Symposium on Raptor Rehabilitation, Captive Breeding and Public Education. For more information contact Dr. Richard R. Olendorff, U.S. Bureau of Land Management, 2800 Cottage Way, Sacramento, California 95825, or Nancy Venizelous, San Francisco Zoological Society, Stoa Boulevard at the Pacific Ocean, San Francisco, California 94132.

Reviewers for *Raptor Research*, 1984

The subject matter of manuscripts received for publication in *Raptor Research* is very diverse. Numerous individuals throughout the year have generously given of their time and expertise by acting as reviewers for manuscripts submitted for publication. The Editorial Staff expresses its sincere appreciation to the individuals listed below, who, through their efforts as reviewers, have helped to raise the standards and quality of the journal. Those individuals who have contributed reviews of two or more manuscripts are indicated by an asterisk.

David M. Bird*, Douglas A. Boyce, Tom J. Cade*, Richard Clark*, William S. Clark, Michael W. Collopy, Gary E. Duke*, James H. Enderson*, Philip K. Ensley*, David L. Fischer, Glen A. Fox, Mark R. Fuller*, James A. Gessaman, Frances Hamerstrom, Frederick Hamerstrom*, Al Harmata*, Steve Herman, Jerome A. Jackson, James R. Karr*, Lloyd Kiff, Michael N. Kochert*, Carl Marti*, David P. Mindell, James A. Mosher*, Helmut C. Mueller*, Joseph R. Murphy, Richard R. Olendorff*, Lynn W. Oliphant*, David B. Peakall, David T. Rogers, Jr., Steve K. Sherrod*, Joseph K. Scheiring, Gordon R. Ulsch, F. Prescott Ward, Robert C. Whitmore*, Stanley N. Weimeyer, E. William Wischusen*, Neil Woofinden.

ANDERSEN AWARD — The third annual William C. Andersen Memorial Award for the best student paper was presented at the Raptor Research Foundation Annual Meeting in Blacksburg, Virginia, on 27 October 1984. The winner was Mr. Reed Bowman of the Macdonald Raptor Research Centre of McGill University for his paper "Behavior of Widow and Replacement Mates in Wild American Kestrels."

Students wishing to be considered for the 1985 Andersen Award must indicate their eligibility when submitting abstracts. Eligibility criteria were published in *Raptor Research* 16(1):30-32. Questions regarding the 1985 award should be directed to: Dr. Robert Kennedy, Director, Raptor Information Center, National Wildlife Federation, 9412 16th Street, NW, Washington, D.C. 20036.

The Macdonald Raptor Research Centre of McGill University is offering 4 to 6 non-salaried summer student internships with free residence (not board). Internships provide experience in public education, care and rehabilitation of captive raptors as well as **an opportunity to pursue personal research.** Interested candidates should submit two letters of recommendation, a resumé of experience and interests, and an unofficial transcript of college academic records by April 1, 1985 to: Dr. David M. Bird, Director, Macdonald Raptor Research Centre, 21,111 Lakeshore Road, Ste-Anne de Bellevue, Québec H9X 1C0, Tel: 1-514-457-2000, ext. 345.

BIOLOGY OF THE PEREGRINE AND GYRFALCON IN GREENLAND. By William A. Burnham and William G. Mattox. Meddelelser om Gronland, Bioscience 14, 1984: 25 pp., 12 figs., 12 tables. Dkr. 46.75 excl. of VAT and postage. — This paper presents the results of 10 years of study (1972-1981) in western Greenland that took place primarily in the region of Sondre Stromfjord. The study is still ongoing. Much of the data were hard won, especially in the early years. Frequently the researchers had to make week long treks with 25-35 kilos of gear in back packs just to gather data on 2-3 eyries. I still have vivid memories of trudging over the landscape with the survey crew in 1975; backpack so heavy and feet so sore I could hardly walk after a one week trek. Over 40 researchers were involved in data gathering and 9 organizations provided some support. Within this report the bulk of the data deals with the Peregrine Falcon (*Falco peregrinus*). Of the 17 pages containing biological data 9 were devoted to peregrine biology, 3 to Gyrfalcon (*Falco rusticolus*) and the remaining 5 to such topics as migration, banding recoveries, chemical pollutants, and interspecific competition. The biologies presented are not unlike that of both species elsewhere in their circumpolar ranges with but a couple of exceptions. The 2 species were not found to occupy the same cliff simultaneously (although they did in 1984). Part of their discussion attempts to explain why this would have developed in the historical sense. They speculate that food densities as well as the distribution of nests of the Common Raven (*Corvus corax*), which Gyrfalcons usurp for nesting, have been important factors in the dispersion of the 2 species.

A second departure from general peregrine biology was the findings on food habits. While peregrines are noted for their catholic diets this was not the case in Greenland. Four species made up about 90% of the diet in 1973. This probably results from the fact that there just are not large populations of many species to prey on at inland localities. In some ways it is disappointing that so much data were lost by not checking food remains in eyries more thoroughly. For all years of the study productivity was recorded at each eyrie and in most cases young were banded. 1973 was the only year reported with food data. Why weren't food remains systematically collected while in the eyrie? Had such data been collected a better idea of regional food differences, yearly prey fluctuation and biomass consumption at each eyrie may have emerged. Overall, considering the physical and logistic restraints encountered by field parties, this study is a credit to the authors and an important addition to raptor biology. — Clayton M. White.

R A P T O R R E S E A R C H

A QUARTERLY PUBLICATION OF THE RAPTOR RESEARCH FOUNDATION, INC.

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INTERNATIONAL CORRESPONDENT: RICHARD CLARK, York College of Pennsylvania, Country Club Road, York, Pennsylvania 17405

Raptor Research (ISSN 0099-9059) welcomes original manuscripts dealing with all aspects of general ecology, natural history, management and conservation of diurnal and nocturnal predatory birds. Send all manuscripts for consideration and books for review to the Editor. Contributions are welcomed from throughout the world, but must be written in English.

INSTRUCTIONS FOR CONTRIBUTORS: Submit a typewritten original and two copies of text, tables, figures and other pertinent material to the Editor. Two original copies of photographic illustrations are required. *Raptor Research* is published in a double-column format and authors should design tables and figures accordingly. **All submissions must be typewritten double-spaced** on one side of 8½ x 11-inch (21½ x 28cm) good quality, bond paper. Number pages through the Literature Cited section. The cover page should contain the full title and a shortened version of the title (not to exceed 30 characters in length) to be used as a running head. Author addresses are listed at the end of the Literature Cited section. Authors should indicate if present addresses are different from addresses at the time the research was conducted. When more than one author is listed, please indicate who should be contacted for necessary corrections and proof review. Provide an abstract for each manuscript more than 4 double-spaced typewritten pages in length. Abstracts are submitted as a separate section from the main body of the manuscript and should not exceed 5% of the length of the manuscript. Acknowledgements, when appropriate, should immediately follow the text and precede the Literature Cited. Both scientific and common names of all organisms are always given where first appearing in the text and should conform to the current checklists, or equivalent references, such as the A.O.U. Checklist of North American Birds (6th ed., 1983). Authors should ensure that all text citations are listed and checked for accuracy. If five or fewer citations appear in the text, place the complete citation in the text, following these examples: (Brown and Amadon, *Eagles, Hawks and Falcons of the World*. McGraw-Hill, New York. 1968), or Nelson (*Raptor Res.* 16(4):99, 1982)). If more than five citations are referenced, each should include author and year (e.g., Galushin 1981)), or in a citation with three or more authors, the first author and year (e.g., (Bruce et al. 1982)). Citations of two or more works on the same topic should appear in the text in chronological order (e.g., (Jones 1977, Johnson 1979 and Wilson 1980)). Unpublished material cited in the text as "pers. comm.," etc., should give the full name of the authority, but must not be listed in the Literature Cited section. If in doubt as to the correct form for a particular citation, it should be spelled out for the Editor to abbreviate.

Metric units should be used in all measurements. Abbreviations should conform with the Council of Biology Editors (CBE) Style Manual, 4th ed. Use the 24-hour clock (e.g., 0830 and 2030) and "continental" dating (e.g., 1 January 1984).

Tables should not duplicate material in either the text or illustrations. Tables are typewritten, **double-spaced throughout**, including title and column headings, should be separate from the text and be assigned consecutive Arabic numerals. Each table must contain a short, complete heading. Footnotes to tables should be concise and typed in lower-case letters. Illustrations (including coordinate labels) should be on 8½ x 11-inch (21½ x 28cm) paper and must be submitted flat. Copies accompanying the original should be good quality reproductions. The name of the author(s) and figure number should be penciled on the back of each illustration. All illustrations are numbered consecutively using Arabic numerals. Include **all** illustration legends together, typewritten **double-spaced**, on a single page whenever possible. Line illustrations (i.e., maps, graphs, drawings) should be accomplished using undiluted india ink and designed for reduction by 1/3 to 1/2. Drawings should be accomplished using heavy weight, smooth finish, drafting paper whenever possible. Use mechanical lettering devices, pressure transfer letters, or calligraphy. Typewritten or computer (dot matrix) lettering is **not** acceptable for illustrations. Use of photographic illustrations is possible but requires that prior arrangements be made with the Editor and the Treasurer.

A more detailed set of instructions for contributors appeared in *Raptor Research*, Vol. 18, No. 1, Spring 1984, and is available from the Editor.

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